AN EXPERT SYSTEM FOR MEASURING, INTERPRETING, AND MANAGING SYSTEM PERFORMANCE FACTORS FOR THE WORK INFORMATION MANAGEMENT SYSTEM

THESIS

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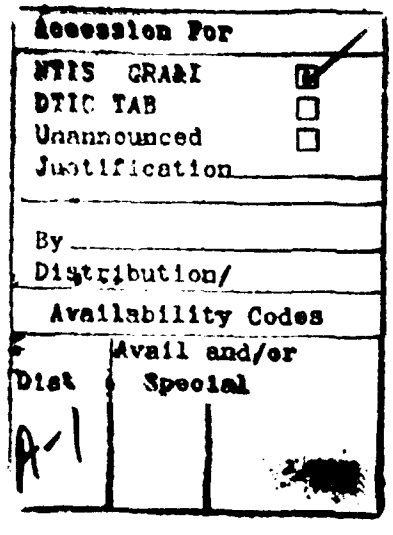

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THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
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In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Software Systems Management

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Preface

This study develops an expert system for measuring, interpreting, and managing the Wang VS operating system performance factors for the Work Information Management System. The expert system provides information about the system parameters, VTOC cache and SHARER buffer pool, and suggests settings for parameters that can improve system performance.

The expert system uses the expert system shell, ExpertR. ExpertR is the only shell that works on the Wang virtual memory system. I would like to thank Mr. Bill Spaulding and Mr. Ed Fink for allowing me access to their computer systems.

In writing this thesis, I had much help. I would like to thank Lt Col James Holt for his effort and comments, but most of all for his patience. I would also like to thank my classmates for pushing me to finish.

Finally, I would like to thank my wife, Sara, for her support and understanding throughout this study.

Billy Joe Cole Irwin

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Abstract

This study develops an expert system for measuring, interpreting, and managing the Wang VS operating system performance factors for the Work Information Management System. The system's performance concerns least known to system administrators are identified. Of these, SHARER buffers and VTOC cache are identified as factors that can significantly impact system performance with little effort.

A six step process is used in developing the expert system. Concept maps representing the structure of the Wang VS Disk Input/Output problem domain are provided. The expert system provides information about the system parameters, SHARER buffers and VTOC cache, and recommends main memory allocations. The expert system is particularly useful to inexperienced system administrators. Sample executions of the system are provided.

The expert system uses the expert system shell, ExpertR by Coyne Kalajian Inc.

AN EXPERT SYSTEM FOR MEASURING, INTERPRETING, AND MANAGING SYSTEM PERFORMANCE FACTORS FOR THE WORK INFORMATION MANAGEMENT SYSTEM

I. Introduction

Overview

Since the development of the Air Force Civil Engineering's Work Information Management System's (WIMS), the requirements have continued to change. The original hardware configuration was designed to support about 30 workstations but as more users needed access to the system, more workstations were added. The typical WIMS is currently supporting over 128 workstations (3). Repeated expansion of system requirements has led to the WIMS operating at capacity where any system inefficiencies would have a direct impact on the systems performance (17:1-2). Individual parameters which affect system performance can be adjusted. However, because of their interdependent relationships, groups of parameters must be adjusted in concert to produce performance improvements. Depending on the situation, adjusting some parameters may have no affect on system performance. Inexperienced system administrators (SA) and system criticality are two additional factors which reduce the amount of system tuning performed.

Factors Contributing to Problem

Rather than chance system crashes, a SA may prefer to maintain the status quo (12). The fact that the WIMS is considered critical to Civil Engineering operations and must remain on-line deters many SAs from adjusting system parameters. Often the SAs must learn from trial and error how to tune their Wang system. Some trial changes can lead to system crashes.

Another factor that causes systems to go without tuning is the experience level of the SA. Since not all SAs are experts, they may not be familiar with all the parameters that affect system performance. Also, balancing the parameters which affect system performance is difficult and time consuming. The Air Force Institute of Technology offers a course to SAs that deals with WIMS management and initial parameter settings (3). However, as the workload of a system changes so do the optimal parameter settings. There are commercially sponsored classes for performance analysis and tuning, available to SAs, however, due to employee turnover or simply employee forgetfulness the information benefit from these courses is minimal (5).

Specific Problem

Air Force Civil Engineering has an estimated 1000 hours of lost work time per base per year due to improperly tuned WIMS mini computers (17:5-5). How can a system administrator with little formal training in system

performance analysis learn about and maintain such a complex system at high performance levels?

Purpose of Research

This research develops an expert system that will measure performance factors, measure the effectiveness and efficiency of the mini computer, interpret the factors, and recommend adjustments to the Wang operating system to improve system performance. The research will demonstrate that expert system technology can be utilized in assisting the SA in tuning the mini computer; identify areas of mini computer performance analysis work that can be inserted into an expert system; and identify what shell should be used.

Scope and Limitation of Research

The scope of this research is to develop a prototype expert system which incorporates the knowledge found in available literature and Wang manuals. The research's purpose is to demonstrate the feasibility of using an expert system in assisting the SA with system performance tuning.

II. Literature Review

Overview

This chapter provides a summary of the factors which affect the Wang system's performance. This chapter will also provide information on expert systems, a technology which will be used to allow fast access to performance factors and provide a means to manipulate these factors. The chapter will conclude with a brief description of ExpertR.

Factors Determining Performance

Lippold and Ferrari have identified several factors which affect the performance of computer systems. These factors are summarized in Table 2-1.

Lippold's definitions of workload, CPU speed, system resource demand, main memory, input/output (I/O), and data storage concerns closely match Ferrari's definitions of workload, main memory, speed/number of devices containing the paging areas, and locality of the programs in the workload, respectively.

Workload. The term workload represents all processing requests that are submitted to the system over a given time period. Workload is a form of demand for system resources. If the workload submitted exceeds the computer system's

Table 2-1 Factors Which Affect System Performance (17:2-4 - 2-30) (9:282)

PERFORMANCE FACTORS	
LIPPOLD	FERRARI
Workload	Workload
System resource demand	CPU speed
Main memory	Main memory size
I/O - Disk I/O - Paging I/O - VTOC I/O - DATA I/O - Buffers for non-shared data - I/O distribution - I/O errors	Speed of devices containing the paging areas Number of devices containing the paging areas Locality of programs in the workload
Data storage concerns - drive speed - Fragmentation and block splitting - Available free space - File packing factors and compression - Disk fault tolerance settings - File placement - Page pool management - Location on disk - Size of page pools - Location among disks	

processing capacity "large internal queues will develop and system performance will degrade significantly" (17:2-5).

The following WIMS workload is identified as serious resource consumers (17:2-5) (4).

1. Base Engineering Automated Management System (BEAMS) to WIMS processing. This process transfers 26 temporary BEAMS files from tape to the WIMS system.

Multiple programs then translate these BEAMS files into a WIMS file called BEAMDATA.

2. WIMS to BEAMS processing. This operation conducts a record by record comparison between BEAMDATA and corresponding WIMS files, then creates BEAMS transactions as needed. The transactions are then copied to tape.

3. Backup and restore processing. Here backup files are created on disk or tape and then restored or rewritten over the original file.

4. Civil Engineering Material Acquisition Systems (CEMAS) days end processing. This process creates material transactions as needed.

System Resource Demand. While the workload creates the demand for the systems resources, the system's ability to process the workload is constrained by its central processing unit, main memory, data storage capacity, and, for the VS, I/O controllers (17:2-7).

The operating system's time sharing algorithm allocates central processor time to the workload. The systems performance can degrade if the time required to process the workload is so large that the central processor is at 100 percent or more utilization. Queues are created if the central processor reaches 100 percent utilization and more workload is added. This situation will degrade the system performance. If a system is performing poorly, it is likely that the central processor is idle, waiting for much slower processes, such as, I/Os (17:2-7).

Main Memory. Main memory is the working space of the mini computer. Main memory size sets the limit to the

amount of workload, paged programs, and data that can be in random access memory at any time. Ferrari suggests that the performance of a virtual memory system is strongly dependent on the systems main memory (9:285). Wang VS system's main

Table 2-2 Wang VS System Memory Limitations (3)

Wang VS System	Maximum Memory
VS-85	6MB
VS-6	8MB
VS-100	16MB
VS-5000	16MB
VS-7310	32MB

memory is hardware constrained. Table 2-2 identifies memory limitations of five VS systems. The main memory on a Wang VS is physically divided into 2048 bytes (2k) blocks or pages. Main memory is allocated between the VS operating system, volume table of contents (VTOC) cache, SHARER buffers, application programs, and the user's modifiable data area. The VS operating system 7.14 requires at least two megabytes of main memory. Application programs such as WP Plus, Wang Office, Pace, and Focus require about one megabyte each (15:2).

Input/Outputs. An I/O is the transfer of information to or from main memory and any peripheral device (17:2-8).

Disk I/O's are particularly performance costly because of the physical speed of the hardware. A Disk I/O requires data to be retrieved from a peripheral disk drive. This retrieval time includes the data search time. That is, the time spent in a queue waiting for processing, plus the head's seek time, plus the disk's rotational delay plus the data transmission time sum to data search time (9:284). Access to data stored on disk can take about 50,000 times longer than access to data in main memory (17:2-9).

The two types of Disk I/O are Serial I/O and Parallel I/O. Serial I/O connects to a workstation or printer. Parallel I/O actions include VTOC misses, SHARER buffer misses, and programs and data files being paged in and out (14).

The VTOC cache stores the file directory information. The system accesses the VTOC cache to find file locations. A hit occurs when the system finds the file directory information in the cache. A hit eliminates the need for an I/O inquiry to disk VTOC. A miss occurs when the system does not find file directory information in the cache. A miss generates an I/O action to the disk VTOC. Statistics concerning VTOC cache hits and misses are found using the operators console. The system administrator can allocate between five and 255, blocks of memory to VTOC cache using the GENEDIT utility.

Files opened in shared mode can be concurrently updated by several users (21:8-1). The Wang VS Data Management System automatically stores shared file blocks in the SHARER buffer pool. Each block contains 2k of data. The system accesses the SHARER buffer pool to find any requested data block. A hit occurs when the system finds the requested block in the buffer pool. A hit eliminates the need for an I/O to a disk file. A miss occurs when the system does not find the requested block. A miss generates an I/O to a disk file (21:9-5). Statistics concerning SHARER buffer pool hits and misses are found using the program SHRSTAT. The system administrator can allocate between three and 255 blocks of memory to the SHARER buffer pool using the GENEDIT utility. GENEDIT doubles the number of blocks allocated for the SHARER buffer, therefore the actual allocation is between six and 510 blocks (4).

A virtual memory system allows for pages or sections of programs to be exchanged from main memory back and forth to disk. The central processing unit only processes that part of a program residing in main memory. Therefore any section or page of a program or data that is not resident in main memory must be retrieved from disk memory before processing can be completed (9:277). This is accomplished in the form of a Paging I/O.

Modifiable data area (MDA) or segment two memory contains the actual data that users are manipulating.

Unlike VTOC cache and the SHARER buffer pool, MDA is not incremented in 2k multiples. The system administrator can allocate between 64k and 8000k main memory to MDA using the GENEDIT utility (4).

When main memory is fully allocated, increasing the amount of memory allocated to any one of the above items, will reduce the amount of memory available for the other four. Therefore, the system administrator must consider all requirements when balancing main memory allocation.

Data Storage Concerns. Data storage concerns include hardware speeds, file locations on disks, number of extents used by data, free extents, and data distribution among disks. An extent is a group of contiguous 2k blocks allocated on the disk for use by a particular file and a 'free' extent is a section of available disk space with no file allocated (17:A-2).

As stated earlier, hardware speeds are set by the mechanical device and are much slower than direct access to main memory. Hardware speeds can only be improved by upgrade or replacement of existing hardware.

Data location on disks affect the amount of time required by the read head to seek a particular file. Likewise, segmented files that are spread out among many extents increase the amount of time needed to retrieve a file. Also, if free extents are spread throughout a disk,

files will be broken up to fill the available free extents when they are written to the disk (9:278).

Tuning

Tuning a computer system means reducing the time the system does unproductive work, such as paging or excessive Disk I/O. Paging can be reduced by effectively utilizing system main memory. This can be accomplished by properly setting data buffers to eliminate misses. This is not a static setting, as workload changes so must these settings. System tuning will not always eliminate the causes of performance problems but will reduce their effects.

Lippold developed a tutorial for gathering information about performance factors. Getting the information was time consuming. He estimated about five hours for the data gathering (17). The proposed expert system should be able to automate much of Lippold's data gathering process, interpret the data, and provide recommended adjustments to improve system performance.

Rule-Based Expert Systems

Expert systems are a subfield of artificial intelligence (AI). Rule-based expert systems have been around in some form since the mid 1960s (1:5). In her dissertation, Allen identifies several roles for which expert systems are especially suited, two of which are a consultancy role and a checklist role (1:8). Both roles are

applicable to this research. The checklist role requires the expert system to identify those questions that must be answered for a given case. The consulting role enables the expert system to answer questions which would otherwise be answered by the expert. Also, the non-expert has easier access to the information (1:8).

Table 2-3 summarizes some general applications of AI, as identified by Hunt.

Table 2-3 Generic Applications of Artificial Intelligence (13:19,20)

Knowledge Management
- Intelligent data base access
- Logical operations on databases
Learning and Teaching
- Computer aided instruction
- Operation and maintenance instruction
Fault Diagnosis and Repair
- Humans
- Machines
- Systems
Sensor Interpretation and Integration
- Developing meaning from sensor data
- Sensor fusion (integrating multiple sensor inputs to develop high-level interpretations)
Intelligent Assistants
- Medical diagnosis, maintenance aids, and other interactive expert systems
- Expert system building tools

Components of an Expert System

Expert system developers, such as Feigenbaum, McCorduck, and Szolovits, agree that expert systems consist of two components. The two components are 1) domain knowledge and 2) problem solving methods (8:76) (20:48).

Figure 2-1 outlines the basic structure of an expert system.

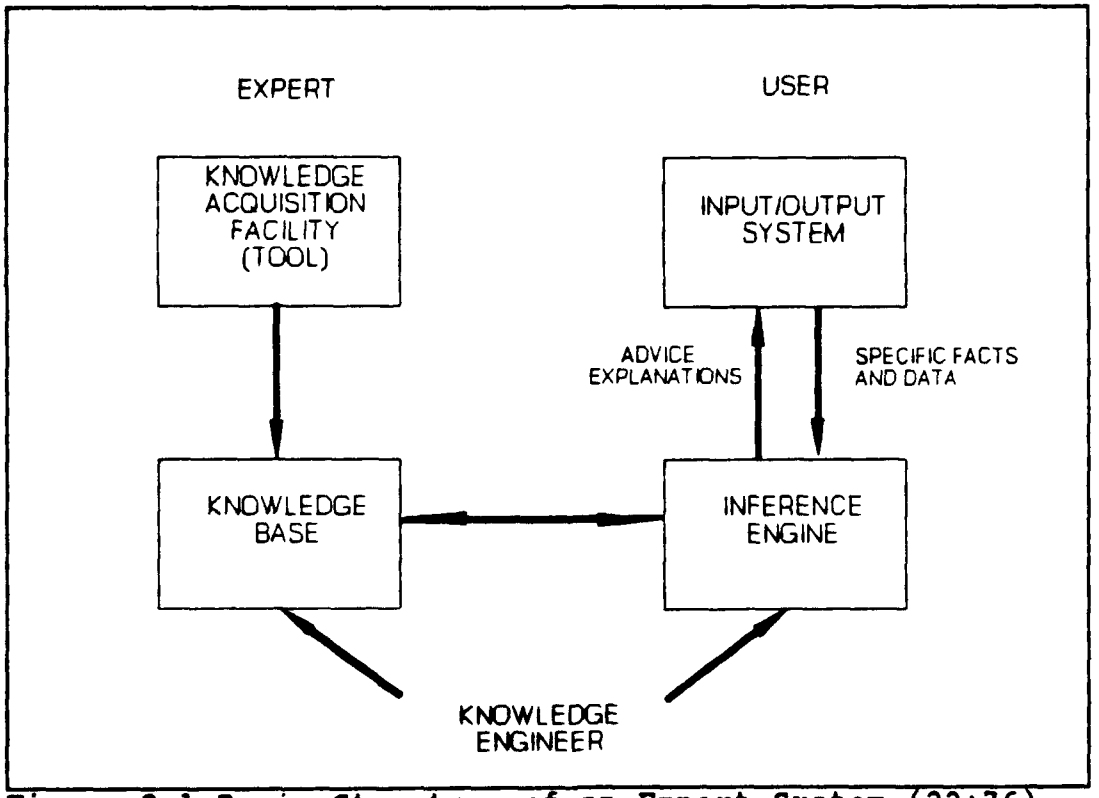


Figure 2-1 Basic Structure of an Expert System (22:76)

Knowledge. Feigenbaum and McCorduck divide knowledge into two distinct classes, those being, "textbook knowledge" and "heuristic knowledge"(8:77). They define textbook

knowledge as "... that which is commonly agreed among practitioners, ... a widely shared knowledge"(8:77). Feigenbaum and McCorduck define heuristic knowledge as "good practice and good judgement in a field. Heuristic knowledge is the experimental knowledge, the art of good guessing that a human expert acquires over years of work"(8:77).

The knowledge base in rule-based expert systems consists of a condition part and an action part. This is usually represented in the form of an if-then decision rule.

The if-then decision rules have the form:

```
If PREMISE
Then CONCLUSION
```

An example of this type of knowledge representation is as follows:

```
If   the Main Memory is less than one mega-byte
Then the Volume Table of Contents cache should be set
     to 24 blocks
```

This research will concentrate on a rule-based representation of knowledge.

Inference Engine. The inference engine is that part of the expert system that uses the knowledge in the knowledge base, applying it to the problem at hand (6:16). The inference engine matches facts in an external data base to the rules of the expert system (20:50).

Backward chaining and forward chaining are two common reasoning techniques used in inference engines. Backward chaining is goal directed. The inference engine processes

rules first by examining their conclusions and then their premises (22:68). The engine progresses backwards through the rules matching conclusion with premises searching for premises that produce the desired conclusion or goal. Sometimes the system works backward to some topics for which there are no rules. At that point, the computer queries the user for facts in order to complete the evaluation of the premise. The system will eventually find or not find the facts to substantiate the premise and the rule becomes true or false (6:17).

Forward chaining systems are fact driven. These systems, given certain facts, reasons forward using all known facts to cause any rule whose premise matches the facts to fire (22:67).

Choice of the inference type is dependent on the problem domain, in some instances one may be preferred to the other or they may be combined. A rule of thumb when choosing an inference type is to start where there are the smallest number of factors such as facts (forward chaining) or with goals (backward chaining).

Expert System Tool

There are many programming languages available for programming expert systems such as PROLOG and LISP that operate on a mini computer. However, ExpertR is the only AI shell that works on the Wang VS Operating System (12).

The ExpertR expert system shell uses the following information structures:

1. Attributes
2. Values
3. A goal
4. A set of rules.

The attributes are primary variables used to describe a circumstance. An example of an attribute, is the number of VTOC cache misses that have occurred. Values are the likely conditions or values that an attribute variable can have. Values can be character strings, integers, or real numbers (7:2-17). The goal is the attribute for which the system is seeking a value. The set of rules "evaluate the values of some attributes to conclude the value of other attributes, and eventually conclude the value of the goal" (7:1-7).

In addition to character, integer, real, and string attributes ExpertR provides three special types of attributes. They are formula, Knowledge Base, and external attributes (7:3-12).

The formula attribute offers the ability to perform calculations within the knowledge base. An example of a formula attribute may be:

#Miss Rate = SHARER Buffer Misses / Seconds

(Note that formula attributes must begin with the # symbol (7:3-19).)

ExpertR's external attributes call subroutines or procedures. This allows for an external source other than the user provide the value of an attribute (7:3-18). This can be effective in saving the user from having to input all attribute values. For instance, if the expert system was evaluating the number of extents on a volume, a procedure can access the volume and return the number of extents in use without requiring the user to access the operator console and manually input the value.

ExpertR expert systems can be nested using Knowledge Base attributes. A Knowledge Base attribute is actually another expert system. Whatever values are concluded for the goal of the module are set for the value of the Knowledge Base attribute in the calling system (7:3-12 - 3-20).

Advanced caption and explanation features allow the user to run any program while viewing the explanation of a value (11:9). These features can access the Wang word processor, WPPLUS. This can provide the new user with extensive explanations or documentation (7:3-24a).

ExpertR offers three inference strategy choices. It provides backward chaining which tries to see if a conclusion is true. It also provides forward chaining to see the possible results of known facts. A benefit of the forward chaining strategy is that the designer can select the order that the values of the attributes will be

determined. Finally, ExpertR offers a forward chaining with backward chaining strategy which allows the user to seek more conclusions (7:2-37 - 2-39) (11:5).

ExpertR also allows the user create a trace of the session in WPPLUS document. The trace includes the recommendations with explanations and it provides a history of the users inputs. This allows the user to document any session.

Summary

The purpose of this chapter was to provide an overview of the factors which affect system performance and of expert systems and to provide a brief description of ExpertR.

III. Methodology

Overview

The purpose of this research is to develop an expert system that will allow fast access to information regarding performance factors and will provide a recommendation for adjusting these factors.

Process

Freiling identifies a step by step process in creating an expert system. He divides the development process into two phases, the first being the "knowledge definition phase" and the second being the "prototype implementation phase" (10:37-52). This step by step process is outlined in Table 3-1.

Table 3-1 Step by Step Approach (10:43)

NUMBER	STEP	RESULT
KNOWLEDGE DEFINITION PHASE		
(1)	Familiarization	Paper knowledge base
(2)	Organizing knowledge	Knowledge acquisition grammar
(3)	Representing knowledge	Internal knowledge base formats
PROTOTYPE IMPLEMENTATION PHASE		
(4)	Acquiring knowledge	Knowledge base
(5)	Inference strategy design	Inference engine
(6)	Interface design	Interface

Step 1: Familiarization. The first step of the knowledge definition phase, familiarization, is intended to determine the project's scope and complexity (10:42). This step will be accomplished by manually running the tests that Lippold proposed in his thesis, attending a system administrator seminar, and talking with system experts.

Step 2: Organizing knowledge. The purpose of this step is to capture the regularities and the structure of the knowledge gained in the preceding step. The result of this step will be rules described in complete English sentences, with the "prepositional phrases" and "relative clauses" highlighted. This knowledge will be considered the "knowledge acquisition grammar" (10:43). An example of the knowledge acquisition grammar is as follows:

```
IF        (1) the VTOC Miss Rate is HIGH
     AND  (2) the VTOC Hit Ratio is LOW,
THEN           (1) the VTOC cache is TOO SMALL.
```

Step 3: Representing knowledge. In this step, the knowledge acquisition grammar will be represented in a structure that will fit within the available development tool. Qualitative characterizations, such as, HIGH, GOOD, and LOW, will be converted to quantitative expressions that the expert system can evaluate. An example of this conversion is as follows:

Qualitative: VTOC Hit Ratio = LOW, GOOD, or HIGH

Conversion: Identify the extremes and determine the range of values that each level can have

Quantitative: Extremes are 0 and 1.0; LOW ranges between 0 and .75, GOOD ranges between .75 and .85, and HIGH ranges between .85 and 1.0

The knowledge that is relevant will be extracted and represented as attributes and rules. The result of this step is the representation of the "internal knowledge base format" (10:44). This internal knowledge will then be utilized by the inference engine.

Step 4: Acquiring knowledge. This is first step of the prototype implementation phase. The knowledge developed in Steps 1-3 will be used to create the prototype knowledge base. The prototype knowledge base will consist of an internal knowledge base that includes rules and attributes to be used by the inference engine (10:45). This prototype knowledge base can be expanded as new knowledge is acquired.

Step 5: Inference Strategy design. In this step of Freiling's methodology, the inference strategy will be selected (10:45). As stated in Chapter Two, ExpertR supports the following inference strategies:

1. Forward chaining
2. Backward chaining
3. A combination of forward and backward chaining (7:3-2)

Step 6: Interface design. Liddle points out in his thesis that the key to a good interface is ease of use (16:34). Four guidelines for interface development are as follows:

1. Keep the screen as sparse as possible.
2. Require as few keystrokes as possible.

3. Use graphics whenever possible.
4. Use windows or hypertext. (2:195)

As well as ease of use the interface must provide recovery from erroneous input. It must provide the user with an explanation or reason for any error. The expert system must also provide information concerning its limitations.

Testing and Validation

The testing and validation of the expert system will consist of two steps, the first step is a program consistency check and the second step is an evaluation by domain experts.

Step 1: Verification. In this step the expert system is checked. Any inconsistencies and redundancies in the knowledge base will be eliminated. The check will consist of executing each rule in the knowledge base.

Step 2: Evaluation. This step consists of a subjective evaluation by domain experts. The results of the experts evaluation of the usefulness of the system is used to evaluate its worth.

Testing will be performed by system administrators at:

1. HQ AFLC/DES, Wright-Patterson AFB, Ohio.
2. 2851DE/DESI, Kelly AFB, Texas.

The two field test sites will be asked a series of questions after sessions with the expert system.

The goal of the testing will be to determine the completeness, accuracy, reliability/consistency, quality of user interface, and quality of the documentation.

Completeness is a measure of missing rules in the knowledge base. Problems with completeness are caused by the impossibility of perfect transference of an experts knowledge to an expert systems knowledge base (18:72). This can be evaluated by statically evaluating the code or by dynamically running the expert system.

Accuracy is the measure of the systems ability to produce recommendations that are the same or close to those that would be given by a human expert. It may not always be necessary to provide perfectly accurate recommendations, but it is important for the system to provide recommendations that are close to those of an expert.

Reliability and consistency measure the expert systems performance compared to that of an expert. Reliability is the ability of the system to generate identical solutions given identical inputs (19:84). If the expert system reproduces the same advice given the same input, it is considered consistent (16:36).

The quality of the user interface is a measure of the ease of use of the expert system. This is an important factor, in that, if the system is difficult to use and does not provide comprehensible recommendations, then the system will in all likelihood not be used.

The quality of the documentation is another measure of the ease of use of the expert system. The documentation provides the user with information regarding upload and use of the system. The documentation also supplements any run time help.

IV. Results and Other Findings

Overview

This chapter discusses how the methodology is followed in building and evaluating the expert system.

Familiarization

As stated earlier, the familiarization step identifies applicable problem domains and sub-domains, and is important in determining the system's scope and complexity. This step included a review of Wang literature, attendance at a system administrator training class and discussion with experienced system administrators. Initial hands on tests of system administrator functions clarified the system tuning tasks performed, and also illuminated areas of performance tuning where the system administrators lack extensive knowledge.

Lippold reviewed the various knowledge areas of system administrators. Table 4-1 summarizes these statistics. (Note that the scale is from 1 to 5, with 1 representing much knowledge of the subject and 5 representing little knowledge of the subject.) The system administrators seem to have the least knowledge in bottleneck detection, volume table of contents (VTOC) cache analysis, SHARER analysis, and file packing factors and compression (17:4-7).

Lippold also asked system administrators where they made efforts to improve system performance. Table 4-2 shows how much attention system administrators give to performance

Table 4-1 Knowledge of Performance Issues (17:4-7)

Knowledge Area	Mean	SD	N	90% Confidence Intervals
Bottleneck Detection	3.56	1.33	9	2.9 - 4.1
VTOC Cache Analysis	3.25	1.18	16	2.8 - 3.7
Performance Indices	3.22	1.17	36	2.9 - 3.5
Sharer Analysis	3.16	0.97	19	2.8 - 3.5
File Packing Factors and Compression	3.0	0.97	16	2.6 - 3.4
User Satisfaction	2.88	1.09	16	2.4 - 3.3
Page Pool Analysis	2.76	1.13	21	2.4 - 3.2
FASTLINK Analysis	2.43	0.98	7	1.8 - 3.0
Disk Drive Analysis	2.0	1.05	30	1.7 - 2.3

concerns. Notice the strong correlation between those areas where little knowledge exists and the areas where system administrators tend to be less involved in performance tuning. VTOC cache analysis, bottleneck detection, file packing factors and compression, SHARER analysis, page pool analysis, and FASTLINK analysis are the areas that receive the least attention (17:4-8). (Note that a higher mean represents more involvement by the system administrator in that area of performance monitoring.)

The statistics show that system administrators give more attention to disk drive analysis than any other performance issue. While disk drive analysis can greatly

Table 4-2 Attention Given to Performance Concerns (17:4-8)

Attention Area	Mean	SD	N	90 % Confidence Intervals
VTOC Cache Analysis	2.20	0.77	15	1.87 - 2.53
I/O Bottleneck Detection	2.22	0.97	9	1.69 - 2.75
File Packing Factors and Compression	2.44	0.89	16	2.07 - 2.81
Sharer Analysis	2.71	0.96	19	2.35 - [illegible]
Performance Indices	2.78	0.99	34	2.50 - 3.06
Page Pool Analysis	3.0	1.0	21	2.64 - 3.36
FASTLINK Analysis	3.0	0.58	7	2.64 - 3.36
User Satisfaction and Impact	3.31	0.60	16	3.06 - 3.56
Disk Drive Analysis	3.7	1.12	30	3.36 - 4.04

reduce the time needed to retrieve files, it does nothing for eliminating the I/O. The statistics also show that system administrators pay little regard to SHARER buffer and VTOC cache analysis. Lippold and others conclude that SHARER buffer and VTOC cache analysis are the two subareas of main memory management where attention is needed (17:5-4) (9:278) (15).

SHARER analysis concentrates on buffer settings and buffer size. The SHARER buffer can be fixed or unfixed. If unfixed the buffer contains records of variable length which eliminates wasted space in the buffer (4). Lippold concluded that unfixed buffers can increase system performance (17:5-4). The buffer is set using the GENEDIT, but the buffer will not be reset until after the next initial program load (IPL). As stated in Chapter 2, optimizing the SHARER buffer size can eliminate I/Os.

VTOC cache analysis concentrates on optimizing the VTOC cache size by evaluating the number of VTOC cache hits and misses. Each VTOC cache hit eliminates an I/O to disk memory, while each miss represents an I/O to disk memory.

Organizing knowledge

In this step the structure of the problem domain was illustrated using concept maps, and the word rules were developed.

Disk I/Os are the most time consuming factors which affect performance. The structure of the I/O domain are represented with concept maps. Concept maps provide a description of the problem domain and the solution space. They identify the relationships among concepts. The concept map in Figure 4-1 describes the Wang VS I/O domain.

At the most abstract level, the I/O concept map, is all inclusive. From this level, less abstract levels add additional information and structure. At a given level of

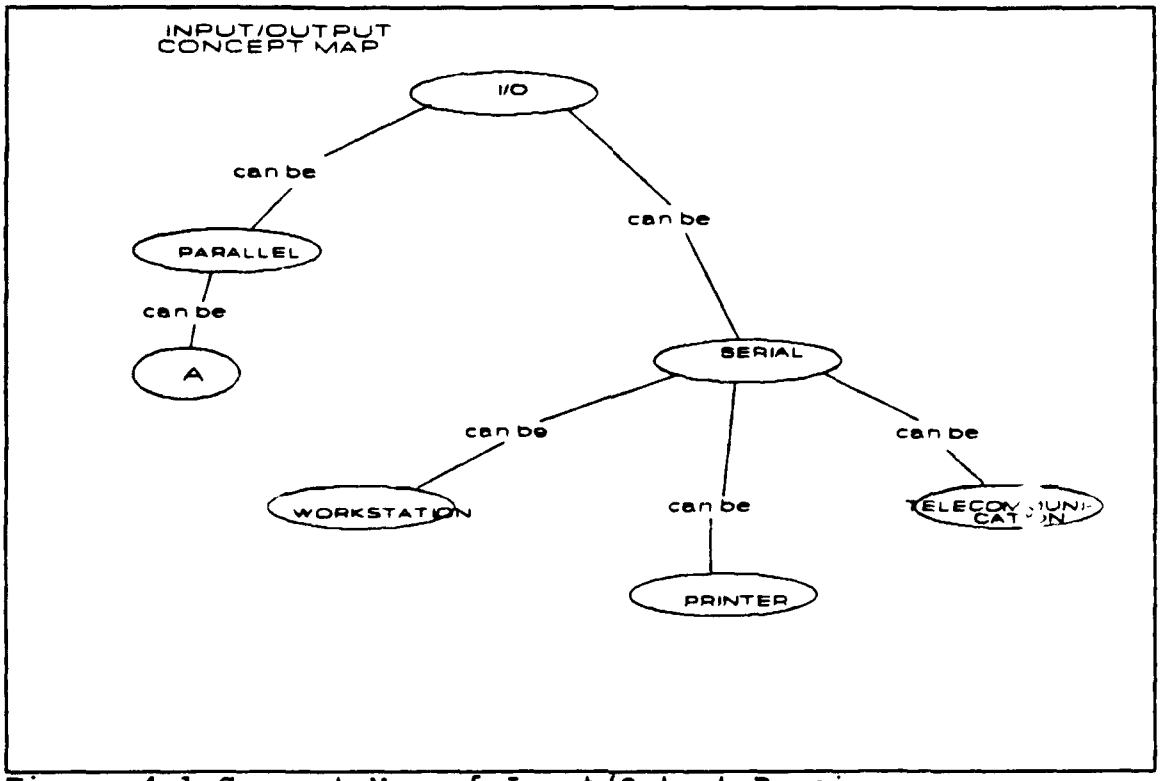


Figure 4-1 Concept Map of Input/Output Domain

abstraction, concepts and relations are identified. A complete set of concept maps show which programs, procedures, or Wang command processor screens provide the needed information for decision making regarding I/Os. The complete set of concept maps are in Appendix B.

Also, in this step the knowledge concerning SHARER buffer and VTOC cache analysis is translated into a rule base form. Factors which affect system performance form the premise of a rule and actions to take when certain conditions exist become the conclusion of the rules. The rules convert the knowledge captured in the concept maps into logical routes to problem solutions.

VTOC cache and SHARER buffer pool size directly affect the number of I/Os performed. These two factors can be monitored and controlled. They are included in the expert system.

Representing knowledge

As stated earlier in Chapter 2, since ExpertR is the only AI shell that works on the Wang VS system it was used as the development tool. This step depicts the knowledge acquisition grammar in a structure that will fit into ExpertR. Rules are identified in Appendix C.

Knowledge in ExpertR is structured in the form of attributes and rules. Attributes are the variables which describe the domain. Attributes are given "values", which represent all of the possible logical states. The expert system searches for the value of a goal attribute. The goal for this expert system is called "Comment". The values of "Comment" are the advice given to the system administrator which suggest changes that can be made to improve system performance.

Other attributes, such as "SHARER Buffer Hits" and "SHARER Buffer Misses", are required to determine the values of "#Hit Rate" and "#Miss Rate which are then used in rules to set the value of "Comment". The complete set of attributes is in Appendix D.

Representing the knowledge in the form of attributes and rules marks the end of the knowledge definition phase.

Acquiring knowledge

In this step, two prototype knowledge bases are created. The two knowledge bases are SHARER Analysis and VTOC Cache Analysis.

The knowledge is grouped into cohesive modules related to particular performance tuning factors. Cohesiveness indicates that a module represents only one aspect of the problem solution. This should facilitate changes and updates to the modules.

The knowledge is modularized using the performance areas identified in the knowledge definition phase. The knowledge was grouped as follows:

SHARER Analysis. This module uses information about SHARER buffer hits and SHARER buffer misses to determine if more main memory blocks should be allocated to SHARER buffers. A sample run of this module is found in Appendix E.

VTOC Cache Analysis. This module uses information about VTOC hits and VTOC misses to determine if more main memory blocks should be allocated to VTOC cache. A sample run of this module is found in Appendix F.

VTOC cache analysis and SHARER analysis detection are functional modules that provide advice on specific areas of performance tuning. Maintaining and updating these modules should be easy since they are self-contained.

Inference strategy design

ExpertR allows the user to choose from backward chaining, forward chaining, and backward chaining with forward chaining.

Initially the backward chaining inference strategy was used. This strategy worked, but, since the shell executes rules in alphabetical order, some users did not gather a logical pattern to the questioning. This confused the users. The forward chaining strategy was then tried.

The forward chaining strategy allows the designer to set the order of the questions by numbering the attributes that serve as data-driven attributes (7:3-2). This strategy worked well for the VTOC Cache Analysis module, but there were problems using this strategy with the SHARER Analysis module. The problem with the SHARER Analysis module and the forward chaining strategy could not be resolved. Finally, a combination of forward chaining control with a backward chaining inference strategy was used. This strategy is used because the order of questions is set by the designer and the user can backward chain to determine more conclusions if desired, and the strategy worked with both modules. The goal attribute was identified as "Comment". After choosing the inference strategy each module was developed independently.

Interface design

This step involved determining what type of user interface the expert system would provide.

Explanations. The modules use ExpertR's documentation capabilities. Explanations are provided for all attribute values and rules.

Keystrokes. ExpertR provides for the creation of run modules, which enable the user to run expert systems without requiring the user to be familiar with ExpertR. ExpertR uses a procedure language program to create the run modules. The modules developed can be run from a menu without having to enter ExpertR, but the ExpertR software must be on the system.

Testing and Validation

Verification: Inconsistencies and redundancies in each module were removed using the forward chaining scheme. A value for each module attribute was provided, then the rules provided conclusions for the goal. The Master Module indicated that some redundant inputs were requested by the functional modules. Those requests were removed.

Evaluation: The system was evaluated by SAs at Wright-Patterson AFB and Kelly AFB. The SAs felt that the system was useful, but would be considerably more useful if the system actually retrieved some of the values for the attributes from the system rather than requiring the user to access the program and then provide the inputs.

The SAs felt that the advice provided by the system was the same that they would give if required to provide it. They felt that further development of the system to include additional modules would provide useful assistance to system administrator in managing the WIMS.

Evaluating Problem

Finding 1: Areas are identified where the system administrators lack extensive knowledge. An expert system that provides the SA with information about performance factors and assists in evaluating system settings could be beneficial to the SA.

Finding 2: This expert system addresses main memory allocation and includes VTOC cache analysis and SHARER buffer analysis. Other performance analysis areas, such as page pool analysis, could be added to the system in order to assist the SA.

V. Summary and Recommendations

Objective

The objective of this study was to develop a system that measures, interprets and manages system performance factors.

Methodology

The methodology used to accomplish this study followed the steps discussed in Chapter 2. In the familiarization step the SHARER buffer size and settings and the VTOC cache size were identified as two of the most important factors in tuning the Wang VS. Identifying these factors helped to determine the focus of the system.

In the organization step the concept maps were useful to illustrate the structure of the Disk I/O problem domain, but they were not as helpful in building the knowledge acquisition grammar. The rules were developed from the available literature on computer system performance tuning and from knowledgeable system administrators.

In the knowledge representation phase the word rules were converted into a format that ExpertR would accept. ExpertR has a feature that coaches the designer when creating rules. This helpful feature allowed attributes to be selected from a list. Rule conversion into ExpertR was complicated because of some peculiarities of ExpertR. One such peculiarity occurs with calculations. ExpertR only

allows one level of nesting which makes some calculations impossible.

In the acquiring knowledge step, the prototype knowledge bases were created. Two knowledge bases, SHARER Buffer Analysis and VTOC Cache Analysis were created. The knowledge bases are independent, so any updating of one will not affect the operation of the other. Some of the documentation features of ExpertR are used in the knowledge bases to provide explanations. Some planned features were omitted because of some quirks with ExpertR's advanced features for captions and explanations. For instance, one planned feature was to allow users to run programs from explanations. ExpertR's manual states that this is possible with the $EXEC feature (7:3-24a). The manual states that, when used in an explanation, the $EXEC feature waits for a prompt from the user before it runs a program. However, the feature runs the program immediately rather than waiting for the user's request. This led to prompts appearing after the program had executed. The knowledge bases were updated to include the expert evaluator's comments.

Research Benefits

The research benefits include the ability to assist the system administrator in evaluating factors that degrade system performance, and also to serve as a foundation for further research in the use of expert system technology in analyzing the Wang VS system performance.

Recommendations

This research concentrated on developing an expert system that addressed the allocation of main memory to eliminate input/outputs. There are many areas of Wang VS system performance that could be added to the developed system. An example is disk drive management which affects the amount of time needed to complete an input/output.

A. Future research could be done to develop the Master Module. This module should consider the interaction of the factors that degrade system performance.

B. Another possible research project could be done to develop a system that accesses information about the VS system that can only be found through the operator screen now. This would eliminate extra user input.

Appendix A: Questions for Testing and Validating the expert system

Subjective Questions:

1. Is the expert system self explanatory or would you like to see more information?

2. Are the expert system's modules presented in a likable manner? If not, what changes would you like to see made?

3. Are explanations provided fast, adequate, or too slow?

4. When using the SHARER Analysis, and VTOC cache Analysis Modules, are the questions self explanatory, too basic, or too difficult to understand?

5. After reviewing the session summary and recommendations, would you have recommended the same thing? If you would not, why not?

6. When using the system did you find the explanations helpful in understanding and tuning your system?

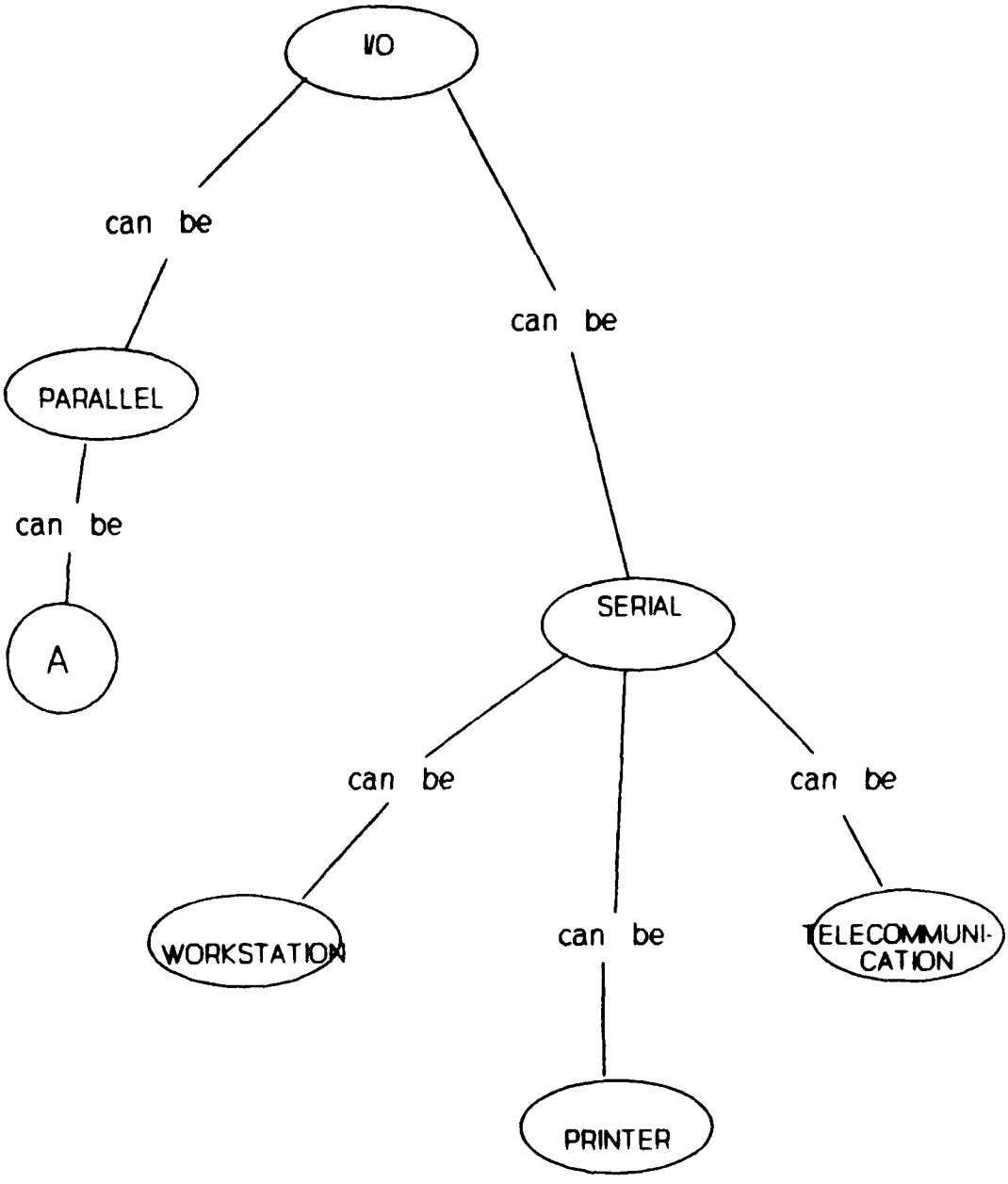
7. If you had an expanded version of the expert system that could provide real time tuning would you find it beneficial for helping you accomplish your work, help you or others train, or do you find it a waste of your time.

8. Did you implement any of the expert system's recommendations. If so did you notice any system performance improvements?

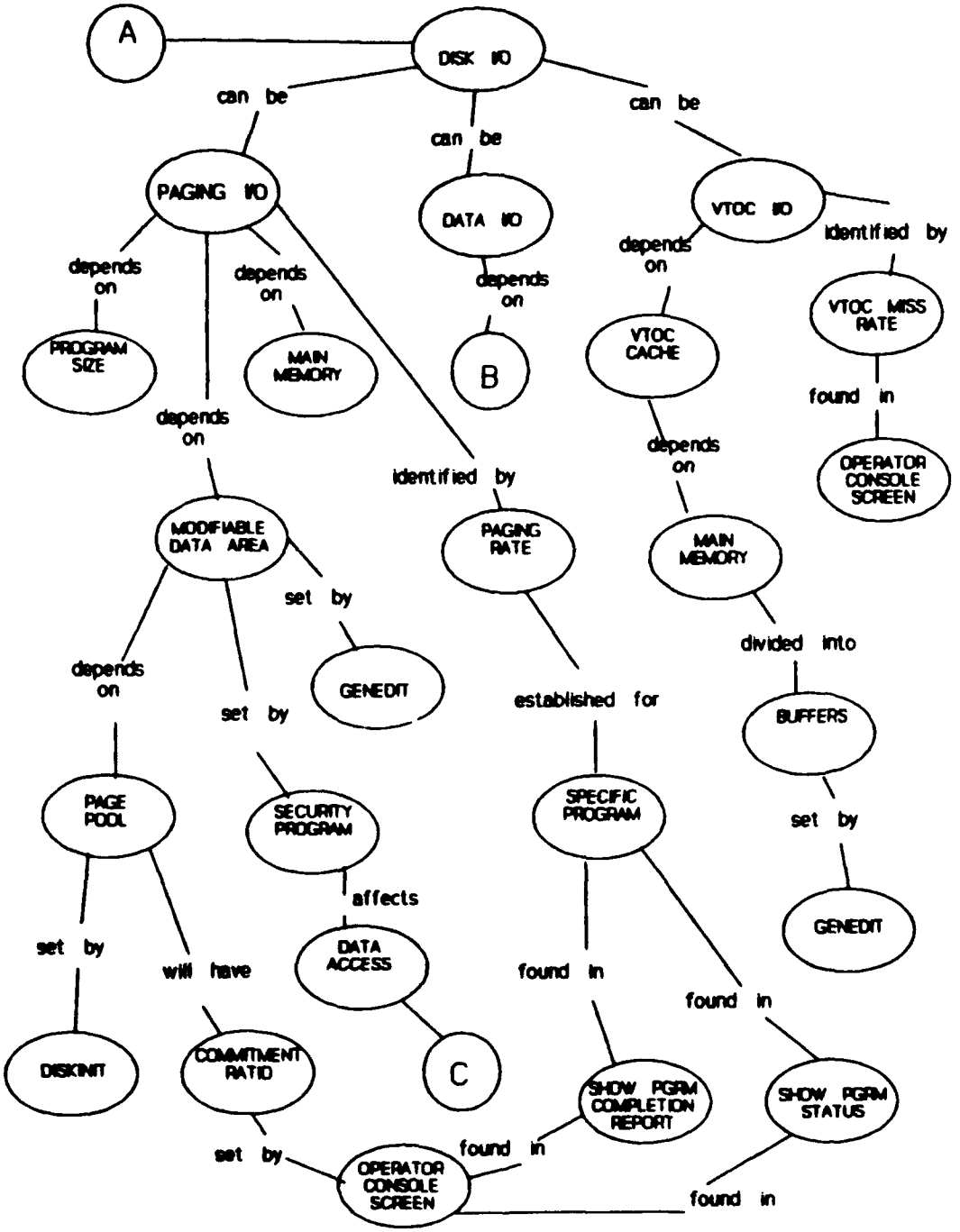
9. Are there any final comments you would like to make about using the expert system?

Appendix B: Concept Maps

INPUT/OUTPUT
CONCEPT MAP

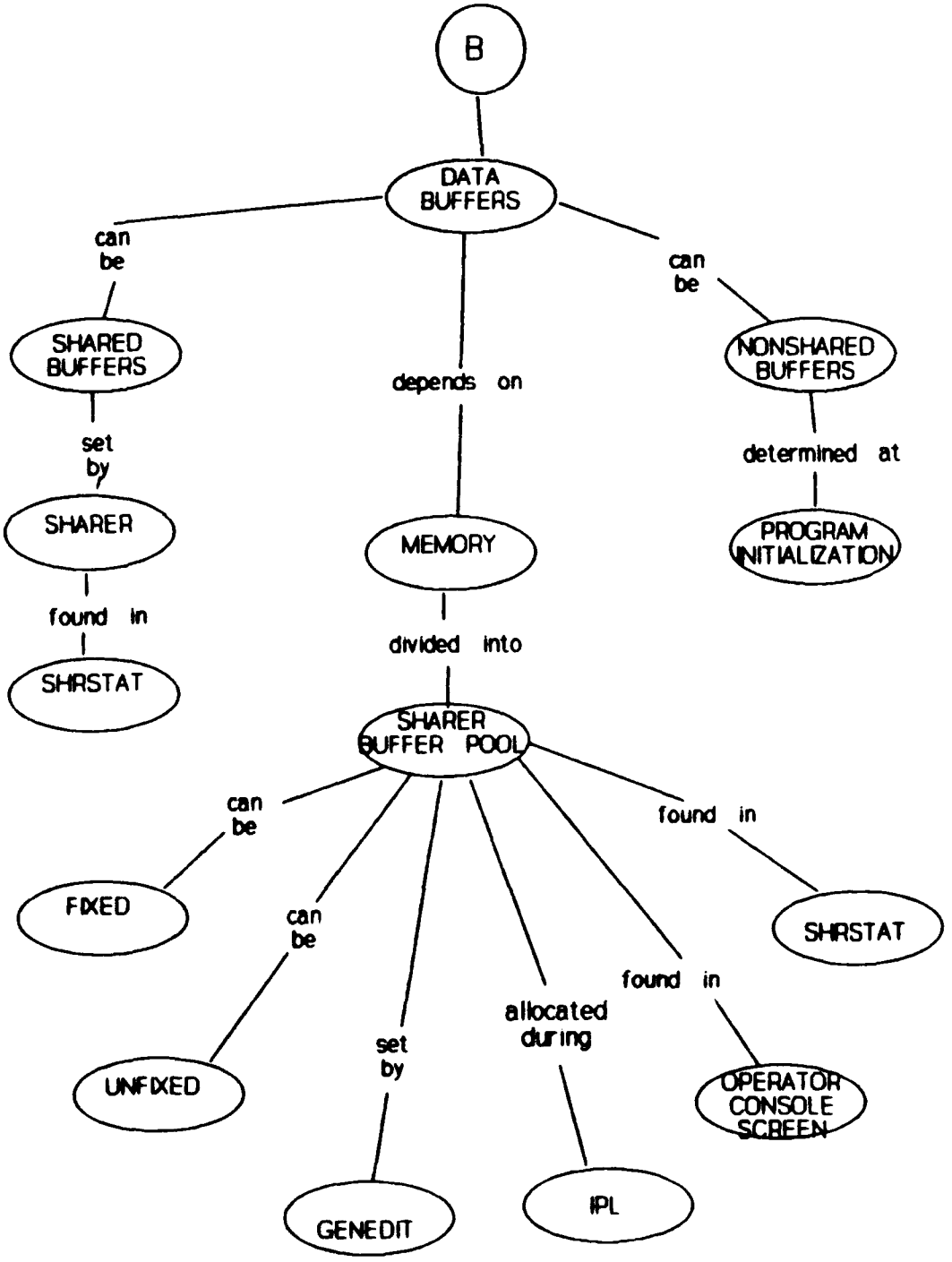


PARALLEL INPUT/OUTPUT CONCEPT MAP

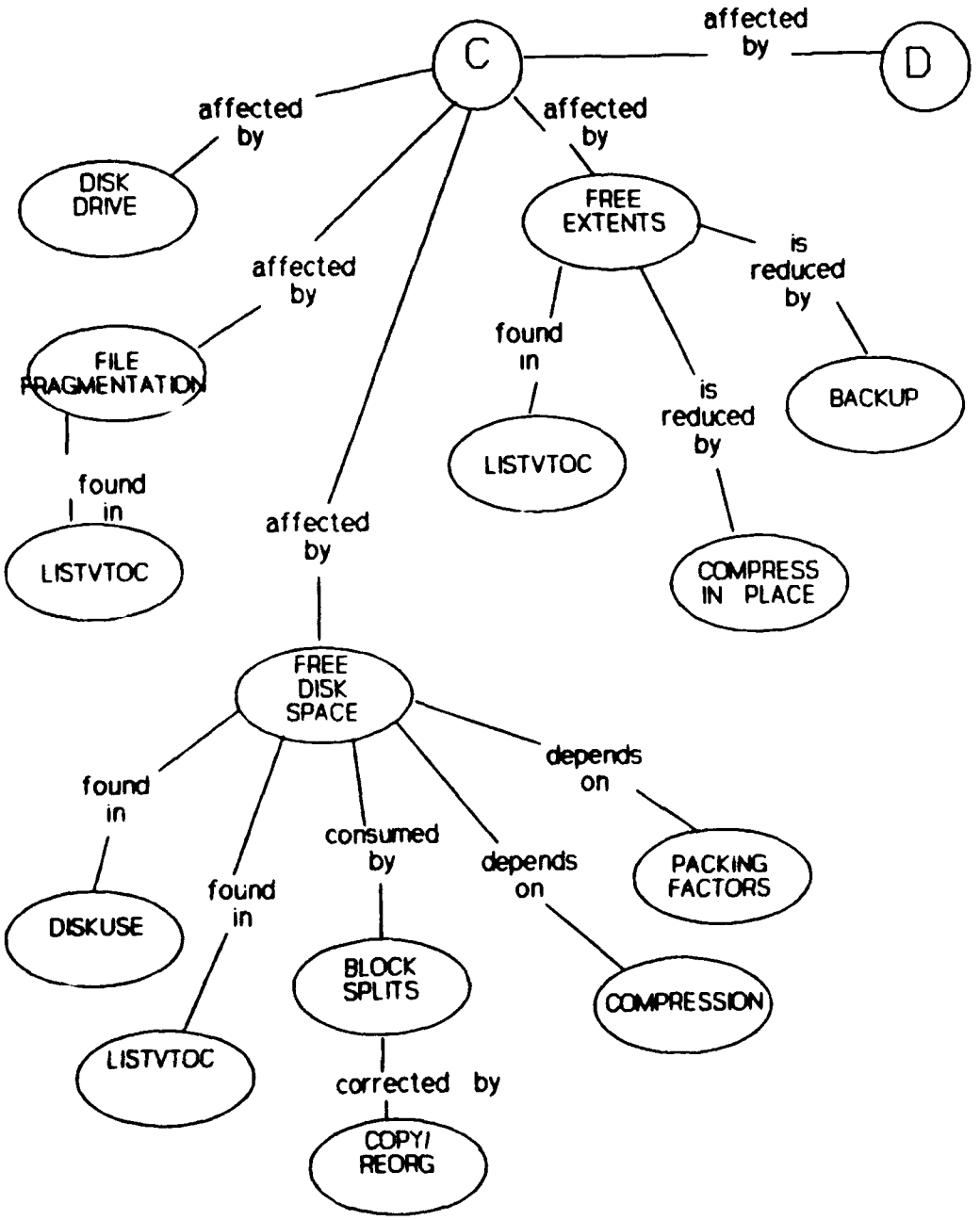


PARALLEL INPUT/OUTPUT

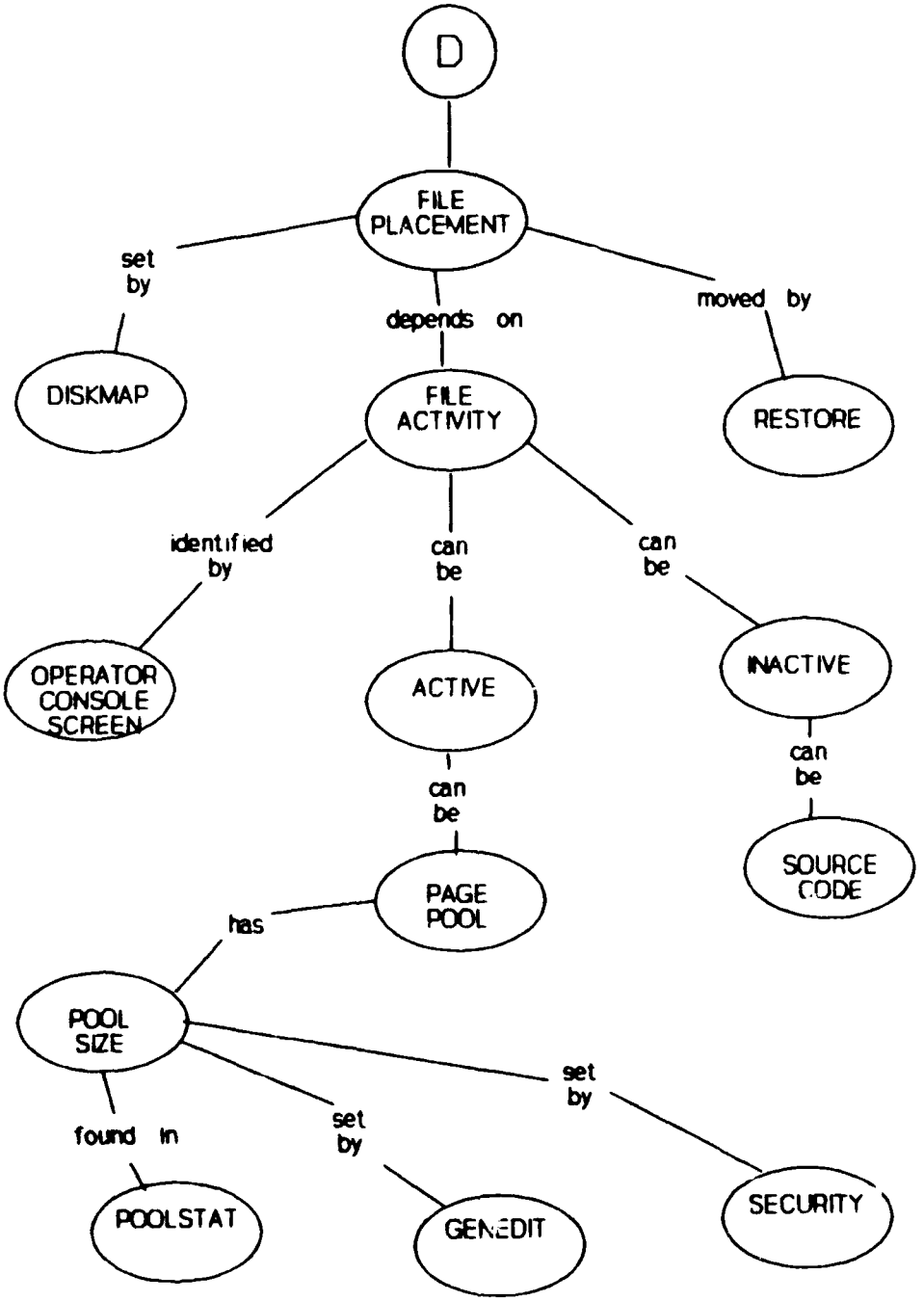
-- DATA I/O



PARALLEL INPUT/OUTPUT
-- DATA ACCESS



PARALLEL INPUT/OUTPUT
-- DATA ACCESS



Appendix C: Rules

Rule : High Miss Rate Rule

IF Confirm = Yes AND [#Miss Rate > 5 AND #Hit Ratio <> 0]
THEN Comment = Try increasing the number of Sharer Buffers < 1.00 > .

The Miss Rate is an indicator of the number of I/Os the system is performing due to sharer buffer misses. I/Os slow the system. By increasing the number of sharer buffers allocated, you improve the chance of the system finding the data needed in main memory. This will eliminate additional I/Os due to sharer buffer misses.

Some system administrators consider more than five misses per second unacceptable.

For more information about the Sharer buffer see:

Wang Laboratories. VS System Performance Guidelines, Part I. 74-0122. Lowell MA, December 1988.

Rule : Low Miss Rate and Good Hit Ratio Rule

IF Confirm = Yes AND #Miss Rate <= 5 AND [#Hit Ratio > .75 AND #Hit Ratio < .85]
THEN Comment = Maintain the current Sharer Buffer setting < 1.00 > .

Some system administrators consider a Miss Rate less than or equal to five per second acceptable. They also consider a Hit Ratio between 75 - 85% acceptable. Since this is the case there is no need to adjust sharer buffers allocated at this time.

Rule : Low Miss Rate and High Hit Ratio Rule

IF Confirm = Yes AND #Miss Rate <= 5 AND #Hit Ratio > .85
THEN Comment = Try reducing the number of Sharer Buffers allowed < 1.00 >.

While a Miss Rate of five or less per second is considered acceptable, a Hit Ratio of greater than 85% is considered non - productive. Therefore it is recommended to reduce the number of sharer buffers allocated. The memory released should be reallocated elsewhere. This does not

released should be reallocated elsewhere. This does not ensure that the Miss Rate will stay at acceptable levels. Reanalyze after adjustments to the sharer buffers are made.

Rule : Low Miss Rate and Low Hit Ratio Rule

IF Confirm = Yes AND #Miss Rate <= 5 AND #Hit Ratio < .75
THEN Comment = Maintain the number of Sharer Buffers currently allowed < 1.00 > .

While a Miss Rate of five or less per second is considered, acceptable, a Hit Ratio of less than 75% is considered low. This situation would appear to occur on a system that was just not being used. It shows that misses are occurring, but just at a slow rate. Continue to monitor.

Rule : Fixed_Control_Blocks_Rule

IF Control Blocks Fixed = Yes
THEN Comment = Maintain fixed Control Blocks < 1.00 > .

Rule : Fixed Control Blocks Rule

IF Control Blocks Fixed = Yes
THEN Comment = Maintain fixed Control Blocks < 1.00 > .

Rule : Large Memory and Unfixed Buffers Rule

IF Main Memory Size > 4 AND Fixed Buffers = No
THEN Comment = Try fixing the Sharer Buffers < 1.00 > .

Rule : Large memory and Fixed Buffers Rule

IF Main Memory Size > 4 AND Fixed Buffers = Yes
THEN Comment = Maintain fixed Sharer Buffers < 1.00 > .

Rule : Small Memory and Fixed Buffers Rule

IF Main Memory Size <= 4 AND Fixed Buffers = Yes
THEN Comment = Try unfixing the Sharer Buffers < 1.00 > .

With fixed buffers all of the records are the same length and no unused space is released. If the main memory is small sharer buffers can be unfixed. This will allow unused space at the end of record to be released.

Rule : Small Memory and Unfixed Sharer Buffers Rule

IF Main Memory Size <= 4 AND Fixed Buffers = No
THEN Comment = Maintain unfixed sharer buffers < 1.00 >
.

Rule : Unfixed Control Blocks Rule

IF Control Blocks Fixed = No
THEN Comment = Try fixing the Control Blocks < 1.00 > .

Fixed control blocks take up little memory and some system administrators think they improve system performance.

*** ExpertR ***

Knowledge Base : VTOC CACHE N

Rule : High Miss Rate Rule

IF Confirm = Yes AND #Miss Rate > 4 AND #Hit Ratio <> 0
THEN Comment = Try increasing the VTOC Cache size < 1.00 > .

The Miss Rate indicates the number of I/Os the system is performing due to VTOC cache misses. I/Os slow system performance. Some system administrators consider greater than four misses per second unacceptable

Increasing the number of cache buffers increases the likelihood of the system finding needed data in memory, which prevents an I/O.

VTOC cache size can be set by GENEDIT. The cache size can be from 5 - 255 buffers. A buffer is 2048 bytes. The cache will not be changed until the next IPL.

For more information about the VTOC cache see:

Wang Laboratories. VS System Performance Guidelines, Part I. 714-0122. Lowell MA, December 1988.

Rule : Low Miss Rate and Good Hit Ratio Rule

IF Confirm = Yes AND #Miss Rate <= 4 AND [#Hit Ratio > .75 AND #Hit Ratio < .85]
THEN Comment = Maintain the current VTOC Cache setting < 1.00 > .

Some system administrators consider a Miss Rate less than or equal to four per second acceptable. They also consider a Hit Ratio between 75 - 85% acceptable. Since this is the case there is no need to adjust cache buffers allocated at this time.

Miss Rates and Hit Ratios are not static, they will change as the workload changes. A Miss Rate that is acceptable now, may be totally unacceptable next week or next month. Therefore, it is important to periodically monitor it and make changes as needed.

For more information about VTOC cache see:

Wang Laboratories. VS System Performance Guidelines, Part I. 714-0122. Lowell MA, December 1988.

Rule : Low Miss Rate and High Hit Ratio Rule

IF Confirm = Yes AND #Miss Rate <= 4 AND #Hit Ratio > .85
THEN Comment = Try reducing the VTOC Cache size allowed < 1.00 > .

While a Miss Rate of four or less per second is considered acceptable, a Hit Ratio of greater than 85% is considered nonproductive. Therefore it is recommended to reduce the number of cache buffers allocated. The memory released should be reallocated elsewhere.

This does not ensure that the Miss Rate will stay at acceptable levels. Reanalyze after adjustments to the VTOC cache are made and the system has been IPLed.

For more information about VTOC cache see:

Wang Laboratories. VS System Performance Guidelines, Part I. 714-0122. Lowell MA, December 1988.

Rule : Low Miss Rate and Low Hit Ratio Rule

IF Confirm = Yes AND #Miss Rate <= 4 AND #Hit Ratio < .75
THEN Comment = Maintain the current VTOC Cache size currently allowed < 1.00 > .

While a Miss Rate of four or less per second is considered, acceptable, a Hit Ratio of less than 75% is considered low. This situation would appear to occur on a system that was just not being used. It shows that misses are occurring, but just at a slow rate.

Continue to monitor.

Rule : Suspect VTOC Miss Data Rule

IF Confirm = Yes AND #VTOC Miss < 0
THEN Comment = Please check values entered for VTOC miss < 1.00 > .

If #VTOC Miss is negative, the user probably entered the VTOC
Miss data incorrectly.

Rule : Suspect VTOC Hit Data Rule

IF Confirm = Yes AND #VTOC Hits < 0
THEN Comment = Please check values entered for VTOC Hits < 1.00 > .

If #VTOC Hits is negative, the user probably entered the VTOC Hits data incorrectly.

Appendix D: Expert System Attributes

*** ExpertR ***

Knowledge Base : Sharer Analysis 2

Attribute

Name : Comment

Value: Maintain fixed Control Blocks

Control Blocks take up little memory and little is gained by freeing them for other tasks.

Value: Maintain fixed Sharer Buffers

Fixing the Sharer buffers will speed up shared file operations. This parameter eliminates the need to page Sharer information in and out of physical memory.
The Sharer buffers can be fixed using the GENEDIT program. The buffers will be fixed after the next IPL.
Continue to monitor system performance .

Value: Maintain the current Sharer Buffer allocation

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered high, however, a Hit Ratio of /*$VALUE (#Hit Ratio) */ is considered great.
Continue to monitor the system. The number of Sharer buffers will likely need to be increased.

Value: Maintain the current Sharer Buffer setting

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered Good; and a Hit Ratio of /*$VALUE (#Hit Ratio) */ is considered Good.
Continue to monitor the system performance.

Value: Maintain the number of Sharer Buffers currently allowed

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered low, while a Hit Ratio of /*$VALUE (#Hit Ratio) */ is also considered low.
The Miss Rate is considered to be more important in determining system performance than the Hit Ratio.

Value: Maintain unfixed sharer buffers

Some system administrators feel the VS runs better with unfixed buffers.

The Sharer buffers can be unfixed using the GENEDIT program. The buffers will be changed after the next IPL.

Value: No analysis will be performed

A value of No was entered for the attribute Confirm.

Value: Try fixing the Control Blocks

Control Blocks take up little memory and little is gained by freeing them for other tasks.

Value: Try fixing the Sharer Buffers

Fixing the Sharer Buffers will speed up Shared file operations. This parameter eliminates the need to page Sharer information in and out of physical memory.

The Sharer Buffers can be fixed using the GENEDIT program. The buffers will not be fixed until after the next IPL.

Continue to monitor system performance after changes are made.

Value: Try increasing the number of Sharer Buffers

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered High, which is more important than a Hit Ratio of /*$VALUE (#Hit Ratio) */.

By increasing the number of Sharer Buffers you will allocate more room in memory for shared data. The larger the Sharer Buffer pool the more likely data will be in it when needed. This may prevent a time consuming input/output.

Value: Try increasing the number of Sharer Buffers allocated

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered High; and a Hit Ratio of /*$VALUE (#Hit Ratio) */ is considered good.

Continue to monitor the Miss Rate and the Hit Ratio. Increasing the number of Sharer Buffers allocated may result

in a higher hit ratio. Some System Administrators recommend an acceptable range of five or less misses per second.

A High Miss Rate with a High Hit Ratio may be caused by someone randomly running programs. Be sure to monitor the Miss Rate.

The size of the Sharer buffer is changed using the GENEDIT program. The size ranges from 3 - 255 blocks. Each block consists of 2kb of main memory. Note: GENEDIT has a flaw, it automatically doubles the number of blocks requested. For example: in GENEDIT you request 130 blocks, the program will assign 260 blocks to the buffer.

Value: Try reducing the number of Sharer Buffers allowed

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered low, while a Hit Ratio of /*$VALUE (#Hit Ratio) */ is considered non-productive.

The low miss rate and the extremely high hit ratio may be signs that too much memory is currently allocated to shared data. Reducing the number of Shared Buffers will release extra memory that can then be reallocated for another use.

The system should be reanalyzed after any changes to determine if Miss Rate and Hit Ratio are still within acceptable ranges.

Value: Try unfixing the Sharer Buffers

Some system administrators feel the VS runs better with unfixed buffers.

The Sharer buffers can be unfixed using the GENEDIT program. The buffers will be changed after the next IPL.

Name : #Hit Ratio

Definition :Real, Prompt Always, KB specified Certainty

Sharer Buffer Hits / (Sharer Buffer Hits + Sharer Buffer Misses)

Name : #Miss Rate

Definition :Real, Prompt Always, KB specified Certainty

Sharer Buffer Misses / Seconds

Name : Sharer Buffer Hits

Definition :Integer, Prompt Remember, KB specified
Certainty

From : 0
To : 5000000

Name : Sharer Buffer Misses

Definition :Integer, Prompt Remember, KB specified
Certainty

From : 0
To : 5000000

Name : Confirm

Value: No

Entering No will return to the menu.

Value: Yes

SHRSTAT will be run.
Please record Time, Misses, Hits and whatever.

Press ENTER, to run SHRSTAT or PF16 to return.
/*$EXEC (SYS001.@SYSTEM@.SHRSTAT) */

Yes will tell the system to continue and SHRSTAT will be run. Please record Time, Misses, Hits and whatever.

Name : Control Blocks Fixed

Value: No

If you do not know if your Control Blocks are fixed, PRESSING ENTER now runs the SHRSTAT utility.

PF - 16 to cancel this explanation.

Value: Yes

If you do not know if your control blocks are fixed or not, PRESSING ENTER will run the SHRSTAT utility. PF16 will cancel this explanation. /* $EXEC (SHRSTAT.@SYSTEM@.SYS001) */

Name : Fixed Buffers

Value: No

The Sharer buffer is that part of main memory allocated to data file blocks that are frequently read (such as the blocks containing index trees). The buffer can be fixed of unfixed using the GENEDIT program. The buffers will be changed after the next IPL.

SHRSTAT shows if buffers are fixed or unfixed. The information can also be found from the Operator Screen by pressing PF14 System Options then PF7 Show System Status.

Value: Yes

In fixed buffers all records are the same length and you are guaranteed not to loose space in a block.

Name : Main Memory Size

Definition :Integer, Prompt Remember, KB specified
Certainty

From : 2
To : 32

Name : Number Sharer Buffers

Definition :Integer, Prompt Remember, KB specified
Certainty

From : 3
To : 255

Name : Number Sharer Buffers

Definition :Integer, Prompt Remember, KB specified
Certainty

What is the number of Sharer Buffers allocated?

This is found by running SHRSTAT.

Whenever multiple users wish to work with the same data file, the system looks at an area of memory where files which can be shared are located. This area is called the Sharer Buffer Pool. If the files needed can not be found in this pool then the system must perform a physical disk read. A larger Sharer Buffer Pool increases the chance of the system finding the file it needs.

```
/* $EXEC (SHRSTAT.@SYSTEM@.SYS001) */
```

```
 *** ExpertR ***                                          ***
Explanation of Value ***

Knowledge Base : VTOC CACHE N

Attribute

Name : #Hit Ratio

  Definition :Real, Prompt Always, KB specified Certainty

     ( VTOC Hits 2 - VTOC hits 1 ) /
     ( VTOC Hits 2 - VTOC Hits 1 + VTOC Miss 2 - VTOC Miss 1
)

Name : #Miss Rate

  Definition :Real, Prompt Always, KB specified Certainty

     (VTOC Miss 2 - VTOC Miss 1) / Seconds

Name : #VTOC Hits

  Definition :Integer, Prompt Always, KB specified Certainty

     VTOC Hits 2 - VTOC Hits 1


Name : #VTOC Miss

  Definition :Integer, Prompt Always, KB specified Certainty

     VTOC Miss 2 - VTOC Miss 1


Name : Comment

  Value: Maintain the current VTOC Cache allocation

     A Miss Rate of /*$VALUE (#Miss Rate) */ is considered
high, however, a Hit Ratio of /*$VALUE (#Hit Ratio) */ is
considered good.


  Value: Maintain the current VTOC Cache setting

     A Miss Rate of /*$VALUE (#Miss Rate) */ is considered
Good; and a Hit Ratio of /*$VALUE (#Hit Ratio) */ is
considered Good.
    A miss means that file location information needed by
the system was not in the VTOC cache, therefore an I/O
```

occurred. If more than four misses per second occur, the VTOC cache may be too small. At this time, your VTOC cache size is considered adequate.

Value: Maintain the current VTOC Cache size currently allowed

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered low, while a Hit Ratio of /*$VALUE (#Hit Ratio) */ is also considered low.

The Miss Rate is considered to be more important in determining system performance than the Hit Ratio.

Value: No analysis will be performed

A value of No was entered for the attribute Confirm.

Value: Try increasing the VTOC Cache size

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered High, which is more important than a Hit Ratio of /*$VALUE (#Hit Ratio) */.

By increasing the number of cache buffers you will allocate more room in memory for file location information. A large VTOC cache is more likely to have needed file information. This may prevent a time consuming input/output. However, it does not guarantee that information will be in the cache.

Value: Try reducing the VTOC Cache size

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered low and a Hit Ratio of /*$VALUE (#Hit Ratio) */ is considered non-productive. Continue to monitor the Miss Rate and the Hit Ratio. Reducing the number of buffers allocated may result in a higher miss rate. If this occurs then slowly increase the number of cache buffers until the Miss Rate falls into an acceptable range. Some System Administrators recommend an acceptable range of four or less misses per second.

A High Miss Rate with a High Hit Ratio may be caused by someone randomly running programs. Be sure to monitor the Miss Rate.

Value: Try reducing the VTOC Cache size allowed

A Miss Rate of /*$VALUE (#Miss Rate) */ is considered low, while a Hit Ratio of /*$VALUE (#Hit Ratio) */ is considered non-productive.

The low miss rate and the extremely high hit ratio may be signs that too much memory is currently allocated to VTOC cache. Reducing the number of buffers will release extra memory that can then be reallocated for another use.

The system should be reanalyzed after any changes to determine if Miss Rate and Hit Ratio are still within acceptable ranges.

Value: Please check values entered for VTOC miss

The number of VTOC misses cannot be /*$VALUE (#VTOC Miss) */.

Knowledge Base : VTOC CACHE N

Value: Please check values entered for VTOC Hits

VTOC Hits cannot be /*$VALUE (#VTOC Hits) */.

Name : Confirm

Value: No

Entering No will return to the menu.

Value: Yes

VTOC cache analysis will be performed.

You will need access to the Operator Screen.

VTOC cache is that part of main memory allocated to file location information.

Name : Seconds

Definition :Integer, Prompt Remember, KB specified
Certainty
From : 1
To : 86400

Name : VTOC Hits 1

Definition :Integer, Prompt Remember, KB specified
Certainty
From : 0
To : 65535

Name : VTOC Hits 2

Definition :Integer, Prompt Remember, KB specified
Certainty

From : 0
To : 65535

Name : VTOC Miss 1

Definition :Integer, Prompt Remember, KB specified
Certainty

From : 0
To : 65535

Name : VTOC Miss 2

Definition :Integer, Prompt Remember, KB specified
Certainty
From : 0
To : 65535

Appendix E: Sample Execution of SHARER Analysis

```
*** ExpertR ***                                  *** Attribute Caption *

Knowledge Base : ASA
Attribute
 Name : Confirm

   Do you wish to perform Sharer Analysis?

   If YES, then SHRSTAT will be run.

   You will need to perform the following:

         1.  Press PF1 to establish a Baseline and write down time.
         2.  Press ENTER after a few minutes and write down time.
         3.  Write down Hit count.
         4.  Write down Miss count.
         5.  Determine the number of seconds between time at 1. and the
             time at 2.

   This information will be used during the analysis.

 Press ENTER to return to the values list

    _ PF-32  Exit
```

Figure E-1 Sharer Analysis Opening Screen

```
*** ExpertR ***                                  *** Select Value ***

   Do you wish to perform Sharer Analysis?

   If YES, then SHRSTAT will be run.

   You will need to perform the following:
 There are more than 6 lines on this caption. Use PF-12 to view entire caption
 _ No
 _ Yes




Press ENTER after positioning cursor to make selection
    _ PF-1 Unable to answer     _ PF-12 View entire caption
                               _ PF-8  View explanation of value pointed to
                               _ PF-9  Find value beginning with: _____
                                                          _ PF-32 Exit
```

Figure E-2 Sharer Analysis Screen Two

```
*** ExpertR ***                                  *** Explanation of Value ***

 Knowledge Base : ASA
 Attribute
  Name : Confirm
  Value: Yes
    Yes will tell the system to continue and SHRSTAT will be run.
    Please record Time, Misses, Hits and whatever.

    Press PF16 to return.









 Press ENTER to return to the values list
    PF-16 to Cancel explanation and return to Conclusion Values
    PF-32  Exit
```

Figure E-3 Sharer Analysis Explanation of Value

```
          *** Wang VS Sharer Statistics - Version 7.18.05 ***
                        [Sharer Version 7.19.22]


      Buffer Pool Information            Sharer Memory Pool Information

      # of buffers: 100                Current memory available: 424820  bytes
         Hit count: 4294164              Least memory available: 297252  bytes
        Miss count: 1183861           Peak memory load occurred at 09:13:42
    Hit/miss ratio: 3.63 to 1                                    on 12/04/91

        DMS Requests Processed             Miscellaneous Information

              Open: 90707               Total messages processed: 3848078
             Close: 90333                     Current # of users: 66
              Read: 3088413             Most simultaneous users: 90
             Write: 98029               Current # of open files: 82
           Rewrite: 97796           Most simultaneous open files: 100
            Delete: 8314
             Start: 291134                Buffers are not fixed
       Adv. Sharing: 29811                Control blocks are not fixed

      Please press <Enter> to update, PF 1 to establish a counter baseline,
              PF 17 to revert from the baseline, or PF 16 to exit
```

Figure E-4 SHRSTAT Screen

```
        *** Wang VS Sharer Statistics - Version 7.18.05 ***
                        [Sharer Version 7.19.22]

    Buffer Pool Information            Sharer Memory Pool Information

    # of buffers: 100                 Current memory available: 426532  bytes
       Hit count: 0                     Least memory available: 297252  bytes
      Miss count: 0                  Peak memory load occurred at 09:13:42
  Hit/miss ratio: 0 to 1                                      on 12/04/91

       DMS Requests Processed             Miscellaneous Information

             Open: 0                     Total messages processed: 0
            Close: 0                          Current # of users: 66
             Read: 0                     Most simultaneous users: 90
            Write: 0                     Current # of open files: 82
          Rewrite: 0                  Most simultaneous open files: 100
           Delete: 0
            Start: 0                     Buffers are not fixed
      Adv. Sharing: 0                    Control blocks are not fixed

     Please press <Enter> to update, PF 1 to establish a counter baseline,
            PF 17 to revert from the baseline, or PF 16 to exit
```

Figure E-5 SHRSTAT Baseline Screen

```
        *** Wang VS Sharer Statistics - Version 7.18.05 ***
                        [Sharer Version 7.19.22]

    Buffer Pool Information            Sharer Memory Pool Information

    # of buffers: 100                 Current memory available: 438484  bytes
       Hit count: 3048                  Least memory available: 297252  bytes
      Miss count: 2361               Peak memory load occurred at 09:13:42
  Hit/miss ratio: 1.29 to 1                                   on 12/04/91

       DMS Requests Processed             Miscellaneous Information

             Open: 142                   Total messages processed: 7071
            Close: 127                        Current # of users: 63
             Read: 6360                  Most simultaneous users: 90
            Write: 9                     Current # of open files: 81
          Rewrite: 49                 Most simultaneous open files: 100
           Delete: 0
            Start: 307                   Buffers are not fixed
      Adv. Sharing: 17                   Control blocks are not fixed

     Please press <Enter> to update, PF 1 to establish a counter baseline,
            PF 17 to revert from the baseline, or PF 16 to exit
```

Figure E-6 SHRSTAT Baseline Update

```
*** ExpertR ***                                  *** Attribute Caption ***

Knowledge Base : ASA
Attribute
 Name : Sharer Buffer Misses

   What is the value of the Sharer Buffer Misses?









Press ENTER to return to the values list

   _ PF-32  Exit
```

Figure E-7 Sharer Analysis Caption

```
*** ExpertR ***                                  *** Select Value ***

   What is the value of the Sharer Buffer Misses?



   2361_____          The value must be an integer

                      The value must be within this range:

                              From:  0
                                To:  5000000



Press ENTER after supplying the integer value
    _ PF-1 Unable to answer the question
                                                          _ PF-32 Exit
```

Figure E-8 Sharer Buffer Hit Screen

```
*** ExpertR ***                                    *** Select Value ***

   What is the value of the Sharer Hits?



   3048_________        The value must be an integer

                        The value must be within this range:

                                From:  0
                                  To:  5000000



Press ENTER after supplying the integer value
    _ PF-1 Unable to answer the question
                                                          _ PF-32 Exit
```

Figure E-9 Sharer Buffer Hits Screen

```
*** ExpertR ***                                    *** Select Value ***

   How many seconds did you let the baseline run?



   120__________        The value must be an integer

                        The value must be within this range:

                                From:  1
                                  To:  86400



Press ENTER after supplying the integer value
    _ PF-1 Unable to answer the question
                                                          _ PF-32 Exit
```

Figure E-10 Time Baseline Run

```
*** ExpertR ***                                  *** Attribute Caption ***

Knowledge Base : ASA
Attribute
 Name : Main Memory Size

   How much Main Memory does your VS currently have?

       Main memory is considered the workbench of the computer system.
   The central processing unit (CPU) can only work on tasks in main
   memory.

       Main memory size can be found from the Operator's Console.  Press
   Press:  HELP, PF11, PF5




Press ENTER to return to the values list

   _ PF-32  Exit
```

Figure E-11 System Main Memory Screen

```
** ExpertR ***                                          *** Select Value ***

   How much Main Memory does your VS currently have?

       Main memory is considered the workbench of the computer system.
   The central processing unit (CPU) can only work on tasks in main
   memory.
 There are more than 6 lines on this caption. Use PF-12 to view entire caption.


   _32__________       The value must be an integer

                       The value must be within this range:

                               From:  2
                                 To:  32




Press ENTER after supplying the integer value
    _ PF-1 Unable to answer the question
    _ PF-12 View entire caption                                  _ PF-32 Exit
```

Figure E-12 Main Memory Value Screen

```
*** ExpertR ***                                    *** Select Value ***

   Are Sharer Buffers fixed?

   This can be found by running the SHRSTAT utility.


 _ No
 _ Yes




Press ENTER after positioning cursor to make selection
    _ PF-1 Unable to answer
                                PF-8  View explanation of value pointed to
                              _ PF-9  Find the value that begins with the
                                      characters: _________      _ PF-32 Exit
```

Figure E-13 Sharer Buffer Analysis

```
** ExpertR ***                                    *** Select Value ***

   Are the system's Control Blocks fixed?

   PF - 8 for explanation


   No
 _ Yes




Press ENTER after positioning cursor to make selection
    _ PF-1 Unable to answer
                                PF-8  View explanation of value pointed to
                              _ PF-9  Find the value that begins with the
                                      characters: _________      _ PF-32 Exit
```

Figure E-14 Control Block Analysis Screen

```
** ExpertR ***                                    *** Concluded Goals ***

Knowledge Base ASA concluded these Goals

  Goal Attribute                                      Number of Conclusions
_ Comment                                                                 3









Press ENTER to view the values concluded for a given attribute
    _ PF- 1 to backward chain for additional conclusions


    _ PF-12 Display conclusion summary
    _ PF-14 Output expls to document        _ PF-15 Print Trace for this run
    _ PF-16 Run another Knowledge Base
    _ PF-32 Exit
```

Figure E-15 Sharer Analysis Concluded Goals

```
*** ExpertR ***                                  *** Concluded Goals ***

Knowledge Base ASA concluded these Goals

  Goal Attribute                                      Number of Conclusions
_ Comment                                                                 3
_ Comment                                                                 3









Press ENTER to view the values concluded for a given attribute


    _ PF-12 Display conclusion summary
    _ PF-14 Output expls to document  _ PF-15 Print Trace for Knowledge Base
    _ PF-16 Run another Knowledge Base
    _ PF-32 Exit
```

Figure E-16 Backward Chain Conclusion Summary

```
** ExpertR ***                                  *** Conclusion Values ***

Knowledge Base ASA concluded these Values for
Goal Comment
  Conclusion                                          Associated Certainty
 _ Try increasing the number of Sharer Buffers                      100%
 _ Try fixing the Sharer Buffers                                    100%
 _ Try fixing the Control Blocks                                    100%




Press ENTER to view Justification of Conclusion



      PF- 8 View explanation of value
    _ PF-14 Output explanations to doc _ PF-15 Print the justification
    _ PF-16 Return to Concluded Goals  _ PF-30 Output single expl to document
```

Figure E-17 Concluded Values Screen

```
*** ExpertR ***                          *** Explanation of Conclusion ***

Knowledge Base : ASA
Attribute                                                Certainty: 100%
 Name : Comment
 Value: Try increasing the number of Sharer Buffers
        A Miss Rate of  19.674999999999 is considered High, which
   is more important than a Hit Ratio of  .5635052689961l.
        By increasing the number of Sharer Buffers you will allocate more
   room in memory for shared data.  The larger the Sharer Buffer pool the
   more likely data will be in it when needed.  This may prevent a time
   consuming input/output.




Press ENTER to return or see the rest of the explanation
   _ PF-16 to Cancel explanation and return to Conclusion Values
```

Figure E-18 Conclusion Explanation Screen

```
** ExpertR ***                          *** Explanation of Conclusion ***

 Knowledge Base : ASA
 Attribute                                                  Certainty: 100%
  Name : Comment
  Value: Try fixing the Sharer Buffers
         Fixing the Sharer Buffers will speed up Shared file operations.
    This parameter eliminates the need to page Sharer information in and
    out of physical memory.
         The Sharer Buffers can be fixed using the GENEDIT program.  The
    buffers will not be fixed until after the next IPL.
         Continue to monitor system performance after changes are made.




 Press ENTER to return or see the rest of the explanation
    _ PF-16 to Cancel explanation and return to Conclusion Values
```

Figure E-19 Conclusion Explanation Screen

```
*** ExpertR ***                        *** Explanation of Conclusion ***

 Knowledge Base : ASA
 Attribute                                                  Certainty: 100%
  Name : Comment
  Value: Try fixing the Control Blocks
         Control Blocks take up little memory and little is gained by
    freeing them for other tasks.




 Press ENTER to return or see the rest of the explanation
    _ PF-16 to Cancel explanation and return to Conclusion Values
```

Figure E-20 Conclusion Explanation Screen

The following is the trace of this session with the SHARER Analysis module:

```
 1)Menu   (3)Position  (5)Next  (7)Up (8)Find
 (15)Print (16)Exit
*** EXPERTR ***      Input Values

Knowledge Base
ASA

Attribute
                              Confirm
Caption

     Do you wish to perform Sharer Analysis?

     If YES, then SHRSTAT will be run.

     You will need to perform the following:

     1.   Press PF1 to establish a Baseline and write down
          time.
     2.   Press ENTER after a few minutes and write down
          time.
     3.   Write down Hit count.
     4.   Write down Miss count.
     5.   Determine the number of seconds between time at 1.
          and the time at 2.

     This information will be used during the analysis.

   Answer
     Yes
     with certainty factor < 1.000>.

Attribute
     Sharer Buffer Misses
  Caption
     What is the value of the Sharer Buffer Misses?
   Answer
     2361
     with certainty factor < 1.000>.

Attribute
      Sharer Buffer Hits
```

```
Caption
     What is the value of the Sharer Hits?
   Answer
     3048
     with certainty factor < 1.000>.

Attribute
     Seconds
  Caption
     How many seconds did you let the baseline run?
   Answer
     120
     with certainty factor < 1.000>.

Attribute
     Main Memory Size
  Caption
     How much Main Memory does your VS currently have?


        Main memory is considered the workbench of the
computer system.   The central processing unit (CPU) can
only work on tasks in main memory.

        Main memory size can be found from the Operator's
Console.  Press
     Press:  HELP, PF11, PF5
   Answer
      32
     with certainty factor < 1.000>.

Attribute
     Fixed Buffers
  Caption
     Are Sharer Buffers fixed?

     This can be found by running the SHRSTAT utility.
   Answer
     No
     with certainty factor < 1.000>.

Attribute
     Control Blocks Fixed
  Caption
     Are the system's Control Blocks fixed?

     PF - 8 for explanation
   Answer
     No
     with certainty factor < 1.000>.

Attribute
```

```
     #Miss Rate
   Answer
     +0000000000000019.67499999999999
     with certainty factor < 1.00   >.

Attribute
     #Hit Ratio
    Answer
     +0000000000000000.56350526899611
     with certainty factor < 1.00   >.

Attribute
     #Miss Rate
   Answer
     +0000000000000019.67499999999999
     with certainty factor < 1.00   >.

Attribute
     #Hit Ratio
   Answer
     +0000000000000000.56350526899611
     with certainty factor < 1.00   >.


*** EXPERTR ***     Justification

Knowledge Base
     ASA

Attribute
     Comment
    Value
     Try increasing the number of Sharer Buffers

  Rule(s)

     High Miss Rate Rule

          The Miss Rate indicates the number of I/Os the
system is performing due to sharer buffer misses.  I/Os slow
system performance.  Some system administrators consider
greater than five misses per second unacceptable.
          Increasing the number of sharer buffers increases
the likelihood of the system finding needed data in memory,
which prevents an I/O.

For more information about the Sharer buffer see:

Wang Laboratories.  VS System Performance Guidelines, Part
I. 74-0122. Lowell MA, December 1988.

IF Confirm = Yes AND #Miss Rate > 5 AND #Hit Ratio <> 0
```

```
THEN Comment = Try increasing the number of Sharer Buffers <
1.00 > .
     Affirmed with Certainty of < 1.000>.


Attribute
     Comment
    Value
     Try fixing the Sharer Buffers

  Rule(s)
     Large Memory and Unfixed Buffers Rule
     IF Main Memory Size > 4 AND Fixed Buffers = No
     THEN Comment = Try fixing the Sharer Buffers < 1.00 > .

     Affirmed with Certainty of < 1.000>.


Attribute
     Comment
    Value
     Try fixing the Control Blocks

  Rule(s)

     Unfixed Control Blocks Rule

          Fixed control blocks take up little memory and
some system  administrators think they improve system
performance.
     IF Control Blocks Fixed = No
     THEN Comment = Try fixing the Control Blocks < 1.00 > .

     Affirmed with Certainty of < 1.000>.
```

Appendix F: Sample Execution of VTOC Cache Analysis

```
*** ExpertR ***                                  *** Attribute Caption ***

Knowledge Base : AVCA
Attribute
 Name : Confirm

   Do you wish to perform  a volume table of contents cache (VTOC cache)
   analysis?

   If yes you will need to perform the following:

     1.  First, you must go to the Operator Console Screen (HELP, PF11)
     2.  From the Operator Console press PF14 System Options, then PF5
         Display System Options
     3.  Write down VTOC cache Hit Count and Miss Count.
     4.  After a few minutes press enter. The hit and miss counts are up-
         dated.  Write down the new VTOC cache Hit and Miss counts.


   This information will be used during the analysis.

Press ENTER to return to the values list

   _ PF-32  Exit
```

Figure F-1 VTOC Cache Analysis Screen One

```
*** ExpertR ***                                  *** Select Value ***

   Do you wish to perform  a volume table of contents cache (VTOC cache)
   analysis?

   If yes you will need to perform the following:

 There are more than 6 lines on this caption. Use PF-12 to view entire caption.
 _ No
 _ Yes









Press ENTER after positioning cursor to make selection
    _ PF-1 Unable to answer     _ PF-12 View entire caption
                               _ PF-8  View explanation of value pointed to
                               _ PF-9  Find value beginning with: _____
                                                                  _ PF-32 Exit
```

Figure F-2 VTOC Cache Analysis Screen Two

```
                    *** System Status ***
                 2:12 pm    Thursday     November 21, 1991

   Position to (_) and press (ENTER) to provide immediate operator service:
_ Printer Error (Device Malfunction) On Printer  76 ..................  14:04
_ Workstation 85, Logon Inhibited, Security Violation.................  13:48


                System has 16384 page frames of 2048 bytes each
                      0 page frames are removed from use

                    32 pages are permanently resident
                   557 pages are temporarily fixed

      VTOC Cache Counts:      Hit =       34218     Miss =       31400

      SHARER Bufpool counts:  Hit =     1278339     Miss =      175770


                        SHARER buffers        are fixed

                          (1) Return to System Options
```

Figure F-3 System Status Screen

```
                    *** System Status ***
                 2:13 pm    Thursday     November 21, 1991

   Position to (_) and press (ENTER) to provide immediate operator service:
_ Printer Error (Device Malfunction) On Printer  76 ..................  14:04
_ Workstation 85, Logon Inhibited, Security Violation.................  13:48


                System has 16384 page frames of 2048 bytes each
                      0 page frames are removed from use

                    32 pages are permanently resident
                   557 pages are temporarily fixed

      VTOC Cache Counts:      Hit =       34237     Miss =       31426

      SHARER Bufpool counts:  Hit =     1278348     Miss =      175783


                        SHARER buffers        are fixed

                          (1) Return to System Options
```

Figure F-4 System Status Screen Two

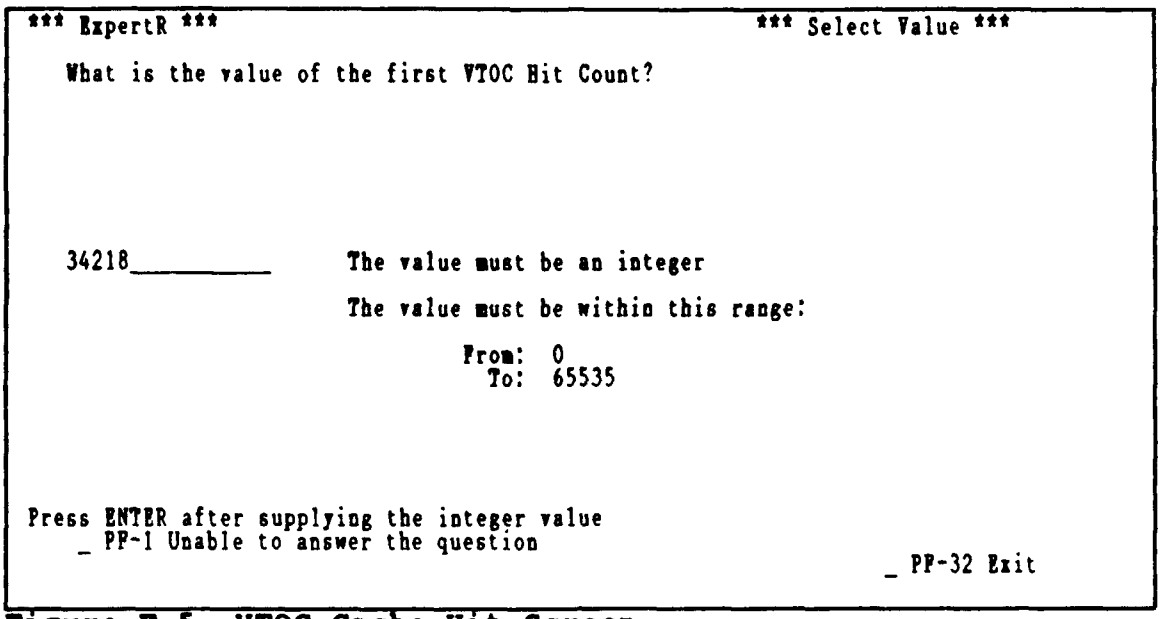


Figure F-5 VTOC Cache Hit Screen

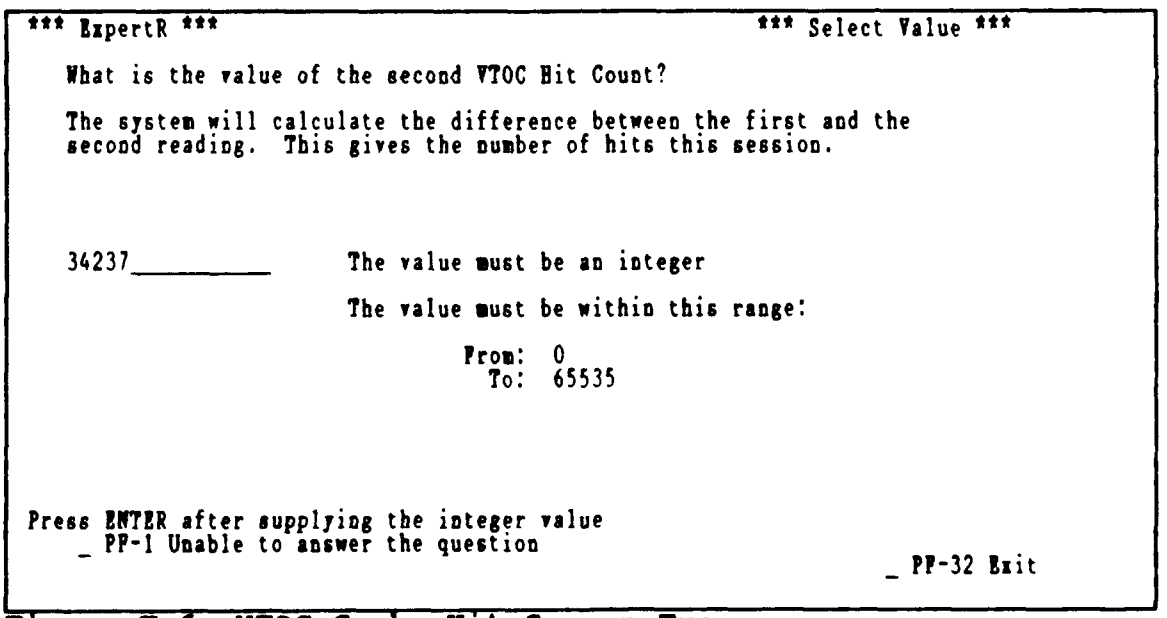


Figure F-6 VTOC Cache Hit Screen Two

```
*** ExpertR ***                                    *** Select Value ***

   What is the value of the first VTOC cache Miss Count?

   The system will calculate the difference between the first and the
   second miss counts.  This will give the misses this session.


   31400_________      The value must be an integer

                       The value must be within this range:

                              From:  0
                                To:  65535


Press ENTER after supplying the integer value
    _ PF-1 Unable to answer the question
                                                          _ PF-32 Exit
```

Figure F-7 VTOC Cache Miss Screen

```
*** ExpertR ***                                    *** Select Value ***

   What is the value of the second VTOC cache Miss Count?

   The system will calculate the difference between the first and the
   second count. This will determine the misses this session.


   31426_________      The value must be an integer

                       The value must be within this range:

                              From:  0
                                To:  65535


Press ENTER after supplying the integer value
    _ PF-1 Unable to answer the question
                                                          _ PF-32 Exit
```

Figure F-8 VTOC Cache Miss Screen Two

```
*** ExpertR ***                                    *** Select Value ***

   How many seconds did you let the baseline run?

   60_____________      The value must be an integer

                        The value must be within this range:

                                From:  1
                                  To:  86400

Press ENTER after supplying the integer value
    _ PF-1 Unable to answer the question
                                                          _ PF-32 Exit
```

Figure F-9 Length of VTOC Cache Baseline

```
*** ExpertR ***                                    *** Concluded Goals ***

Knowledge Base AVCA concluded these Goals

  Goal Attribute                                    Number of Conclusions
_ Comment                                                               1

Press ENTER to view the values concluded for a given attribute

    _ PF-12 Display conclusion summary
    _ PF-14 Output expls to document   _ PF-15 Print Trace for Knowledge Base
    _ PF-16 Run another Knowledge Base
    _ PF-32 Exit
```

Figure F-10 VTOC Cache Analysis Concluded Goals

```
*** ExpertR ***                                    *** Conclusion Values ***

Knowledge Base AVCA concluded these Values for
Goal Comment
  Conclusion                                                Associated Certainty
 _ Maintain the current VTOC Cache size currently allowed                  100%




Press ENTER to view Justification of Conclusion



      PF- 8 View explanation of value
    _ PF-14 Output explanations to doc _ PF-15 Print the justification
    _ PF-16 Return to Concluded Goals  _ PF-30 Output single expl to document
```

Figure F-11 Concluded Values Screen

```
*** ExpertR ***                                *** Explanation of Conclusion ***

Knowledge Base : AVCA
Attribute                                                    Certainty: 100%
 Name : Comment
 Value: Maintain the current VTOC Cache size currently allowed
        A Miss Rate of  .43333333333333 is considered low, while
    a Hit Ratio of  .42222222222222 is also considered low.
        The Miss Rate is considered to be more important in determining
    system performance than the Hit Ratio.




Press ENTER to return or see the rest of the explanation
   _ PF-16 to Cancel explanation and return to Conclusion Values
```

Figure F-12 Conclusion Explanation Screen

The following is the trace of this session with the VTOC

Cache Analysis module:

(1)Menu (3)Position (5)Next (7)Up (8)Find
(15)Print (16)Exit

*** EXPERTR *** Input Values

Knowledge Base
AVCA

Attribute
Confirm
Caption
Do you wish to perform a volume table of contents cache (VTOC cache) analysis?

If yes you will need to perform the following:

1. First, you must go to the Operator Console Screen (HELP, PF11)
2. From the Operator Console press PF14 System Options, then PF5 Display System Options
3. Write down VTOC cache Hit Count and Miss Count.
4. After a few minutes press enter. The hit and miss counts are updated. Write down the new VTOC cache Hit and Miss counts.

This information will be used during the analysis.

Answer
Yes
with certainty factor < 1.000>.

Attribute
VTOC Hits 1
Caption
What is the value of the first VTOC Hit Count?
Answer
34218
with certainty factor < 1.000>.

Attribute
VTOC Hits 2
Caption
What is the value of the second VTOC Hit Count?

The system will calculate the difference between the first and the

```
     second reading.  This gives the number of hits this
session.
   Answer
     34237
     with certainty factor < 1.000>.

Attribute
     VTOC Miss 1
  Caption
     What is the value of the first VTOC cache Miss Count?
     The system will calculate the difference between the
first and the
second miss counts.  This will give the misses this session.

   Answer
     31400
     with certainty factor < 1.000>.

Attribute
     VTOC Miss 2
  Caption
     What is the value of the second VTOC cache Miss Count?

     The system will calculate the difference between the
first and the second count. This will determine the misses
this session.
    Answer

     31426
     with certainty factor < 1.000>.

Attribute
     Seconds
  Caption
     How many seconds did you let the baseline run?

   Answer
     60
     with certainty factor < 1.000>.

Attribute
     #Miss Rate
   Answer
      +0000000000000000.43333333333333
     with certainty factor < 1.00   >.

Attribute
     #Hit Ratio
   Answer
     +0000000000000000.42222222222222
     with certainty factor < 1.00   >.
```

```
Attribute
     #VTOC Hits
   Answer
     +0000000000000019
     with certainty factor < 1.00    >.

Attribute
     #VTOC Miss
   Answer
     +0000000000000026
     with certainty factor < 1.00    >.


*** EXPERTR ***      Justification

Knowledge Base
     AVCA

Attribute
     Comment
    Value
     Maintain the current VTOC Cache size currently allowed

  Rule(s)
     Low Miss Rate and Low Hit Ratio Rule
      While a Miss Rate of four or less per second is
considered, acceptable, a Hit Ratio of less than 75% is
considered low.  This situation would appear to occur on a
system that was just not being used.  It shows that misses
are occuring, but just at a slow rate.  Continue to monitor.

     IF Confirm = Yes AND #Miss Rate <= 4 AND #Hit Ratio <
.75
     THEN Comment = Maintain the current VTOC Cache size
     currently allowed < 1.00 > .
 Affirmed with Certainty of < 1.000>.
```

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Vita

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This study develops an expert system for measuring, interpreting, and managing the Wang VS operating system performance factors for the Work Information Management System. The system's performance concerns least known to system administrators are identified. Of these, SHARER buffers and VTOC cache are identified as factors that can significantly impact system performance with little effort. A six step process is used in developing the expert system. Concept maps representing the structure of the Wang VS Disk Input/Output problem domain are provided. The expert system provides information about the system parameters, SHARER buffers and VTOC cache, and recommends main memory allocations. The expert system is particularly useful to inexperienced system administrators. Sample executions of the system are provided. The expert system uses the expert system shell, ExpertR by Coyne Kalajian Inc.

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